STOPPING WATER POLLUTION AT ITS SOURCE

MISA

Municipal/Industrial Strategy for Abatement

MONITORING COSTS AND THEIR IMPLICATIONS FOR DIRECT DISCHARGERS IN THE ONTARIO MINERAL GROUP "A" SECTOR

FINAL REPORT

Environment Ontario

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Minister

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MONITORING COSTS AND THEIR IM[illegible]TIONS

FOR

DIRECT DISCHARGERS

IN THE

ONTARIO MINERAL GROUP "A" SECTOR

FINAL REPORT

Prepared by
Socio-Economic Section
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ABSTRACT

Estimates of the incremental capital and operating costs to 67 plants which are subject to the provincial Municipal-Industrial Strategy for Abatement (MISA) are derived and their implications evaluated. Cost estimates were developed in cooperation with the Ontario Mining Association (OMA) and the two salt companies. The regulation applies to metal and salt mines and associated refinery and smelting plants, which directly discharge into Ontario's waterways.

Capital and operating costs were estimated for each of the five key monitoring activities:

- sampling requirements
- analytical requirements (characterization and routine analyses)
- toxicity testing
- flow measurement
- reporting

Because of uncertainties as to how mines would implement the sampling requirements two scenarios were developed. One scenario assumes that sampling would be undertaken by mine personnel, while the other scenario assumes sampling is contracted to consultants.

The average incremental costs are estimated to total $13.1 million under the scenario in which mine employees do their own sampling. If consultants are hired to collect samples, costs could total as much as $18.0 million. The average cost per mine ranges from $240,000 to $333,000.

- The gold subsector with 36 mines accounts for approximately 53% of the total monitoring costs.

Total average incremental capital costs vary marginally between the two scenarios, from $3.9 million under consultant sampling to $4.4 million under mine sampling. It has been assumed that capital expenditures are fully deducted against income in one year.

- Flow measurement devices account for approximately 53% of the total costs, sampling requirements make up 35% and reporting accounts for the remaining 12%.

Average incremental operating costs over the 12-month period of the regulation are estimated to range from $8.7 million under the mine sampling scenario to $14.1 million if consultants undertake sampling.

ABSTRACT (Continued)

Routine analyses costs were estimated for an alternative scenario in which all mines tested for the same parameters at the same frequency. This would result in a cost of $5.1 million as opposed to $2.8 million under the proposed requirements. This difference of $2.3 million is a measure cost-effectiveness of adopting the subsector and effluent specific approach.

Monitoring costs incurred by the firms under the MISA regulations will increase operating expenses and, unless there is some offsetting increase in productivity associated with wastestream monitoring, profits to the firms and returns on particular plants will be reduced. Economic effects of the monitoring costs on the industry, and on 17 firms for which financial data are available, are examined. These 17 firms account for 45 of the 67 plants subject to the regulation. The analyses assumes that these companies are not able to pass on any of the monitoring costs.

The financial impacts of the estimated monitoring costs on the Group "A" sector were analyzed using historical financial data for the period 1981-1987.

Monitoring operating costs represent less than 4% of average after-tax profits for nine firms. For two companies, monitoring operating costs would have accounted for over 100% of average after-tax profits for the period. For the remaining six companies, monitoring operating costs represented from between 7.1% to 40.5% of annual after-tax profits (losses).

Monitoring capital costs represent less than 2% of the average annual capital expenditures over the period for all but two companies. For these two companies, monitoring capital costs represented less than 3% of average annual capital expenditures.

Monitoring operating costs would have decreased, on average, both the rate of return on capital employed ratio and the return on assets by less than 1% for 13 of 16 firms. For the other three firms, the rate of return on capital employed ratio declined from between 1.1% to 2.42%, while the return on assets ratio declined from between 2.1% to 4.0%.

Potential benefits to the firms of the monitoring regulation include gains in productivity by improving processes, reduction in raw material losses in wastewater, and goodwill gained by demonstrating to the public that they are responding to environmental problems. Increasingly, costs for protecting the environment are seen as a "cost of doing business" in today's society.

The monitoring regulations could have a positive temporary impact on employment in Northern Ontario, creating up to 52 new jobs. The regulations will also stimulate demand for laboratory services and flow measurement and sampling equipment. Lastly, the monitoring database will be available to design cost-effective control programs aimed at eliminating toxic contamination where it occurs.

1.0 BACKGROUND AND PURPOSE OF REPORT

1.1 MISA Objectives

The MOE's Municipal-Industrial Strategy for Abatement (MISA) is intended to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways."

The MISA program consists of three broad components:

1. Development and promulgation of Regulations which specify (a) contaminant monitoring requirements, and (b) effluent limits.

2. Development of these effluent limits based on "best available technology economically achievable" (BATEA) or water quality impacts.

3. Implementation of abatement programs and enforcement activities.

Economic assessments of each component of the MISA program are also being prepared. These assessments are intended to show the costs of the various regulations and other program elements and the economic and financial implications of these costs.

The MISA program will encompass at least 200 Ontario industrial establishments which discharge contaminants directly into waterways disaggregated into nine industrial sectors:

- petroleum refining
- organic chemical manufacturing
- pulp and paper
- iron and steel
- metal mining and refining
- industrial minerals and manufacturing
- electric power generation
- inorganic chemicals
- metal castings.

The first phase of the MISA regulatory program is the promulgation of monitoring regulations for all plants within each of the industrial sectors.

Other firms and plants in each of the sectors will eventually be subject to monitoring requirements by virtue of a sewer use program being developed by the Ministry.

All direct dischargers are subject to a "General" and "Sector Specific" monitoring regulations. The Mineral Group "A" Regulation will be effective for a 12-month period. Following this 12-month period, plants are required to monitor for contaminants specified under their Certificates of Approval. Further monitoring requirements will then be specified in a subsequent "Effluent Limits Compliance Regulation".

1.2 Definition of the Mining Sector

For purposes of developing MISA regulations, mining operations in Ontario have been divided into two "Groups": A and B. Group "A" includes metal ore producing mines, refineries and smelters together with salt plants. Group "B" consists of non-metallic mines and quarries such as gypsum, cement and other construction materials. This report focuses on Group "A" mines.

Mines subject to MISA regulations are further sub-divided into six sub-sectors according to their product. The number of mines which are subject to MISA monitoring regulations in each sub-sector, including salt, is shown in Table 1.1. A detailed list of the mines involved can be found in Appendix 1. The number of mines subject to the regulation could change in the future as mines come into production and as mines become inactive. To accommodate this, the monitoring regulation is being kept open until October, 1989. At this time, the list of mines subject to the regulation will be finalized.

TABLE 1.1

The Number of Group "A" Mines Subject to MISA Regulations By Subsector As of July 1989

Subsector	No. of Mines
Copper, lead, zinc and nickel	17
Gold	36
Silver	2
Iron	1
Uranium	9
Salt	2
TOTAL	67

The 67 mines are owned by approximately 29 companies. (A.R.A. Consultants, October 1988: Table 1). Mines subject to the MISA monitoring regulations are direct dischargers and discharge over 50,000 litres of effluent per day. If an operation is an exploration site where a mineral product is not being commercially recovered, then it is given an EXP/DEV designation. The monitoring required of an EXP/DEV property is similar to that presently specified under existing Certificates of Approval which these properties are already required to obtain. No significant additional financial outlay is required. In total there are 13 EXP/DEV properties, 11 properties in the gold subsector and two in the silver subsector.

Gold mines with production below 1,000 tonnes per day are not required to monitor for certain parameters as frequently as larger companies. This concession was made to decrease the financial impact on smaller gold mines.

Additional information about the physical and economic dimensions of the metal mining industry in Canada and Ontario may be found in the report, "Industry Profile: The Metal Mining and Refining Sector", A.R.A. Consultants (1988) and in the references cited in that report. Data used in the assessment of economic impacts of monitoring costs were obtained from the A.R.A. report.

1.3 Changes to the List of Mines

The Ontario mining industry is dynamic. Mines change ownership, new mines are opened while others become inactive or are mothballed. Consequently, the number of mines subject to the MISA monitoring regulation has been altered since the public review period to reflect these changes. The regulation now applies to 67 mines rather than 92. Most of these changes have occurred in the gold, silver and iron subsectors.

In the gold subsector, 14 mines have been eliminated from the list because they are no longer discharging 50,000 litres of water a day and are designated as inactive. Three new mines have been added to the list, two of which are designated as EXP/DEV properties. The gold subsector now

consists of 36 mines, 11 of which are EXP/DEV properties. Because of these changes, the monitoring costs for the gold subsector presented in this report are considerably lower than previously estimated.

Seven out of nine mines in the silver subsector have been classified as inactive and deleted from the regulation. Agnico-Eagle which owns five of these mines, has suspended all mining operations in the Cobalt region in January and its mill was mothballed in February. (Globe and Mail, April 12, 1989.) Low silver prices, and increased competition from lower cost base metal producers are cited as some of the reasons for these closures. The silver subsector now comprises of two mines, both of which are designated as EXP/DEV properties.

Lastly, only one mine in the iron subsector remains active compared to three in the previous list. Dofasco announced earlier this year that it would close its Sherman and Adams mine due to the high costs of production. Dofasco plans to purchase ore it needs for its steel plants from lower-cost producers.

1.4 Purpose and Objectives of Present Report

The monitoring requirements for each industrial sector subject to MISA regulations have been developed during negotiations with industry representatives through a Joint Technical Committee (JTC). Cost-effectiveness has been considered in arriving at the agreed-to protocols and requirements.

This report is intended to present estimates of the potential incremental costs to the direct discharging Group "A" plants in Ontario of implementing the sector specific and general monitoring regulations. The costs of monitoring were estimated for the 54 mines. As mentioned above, the 13 EXP/DEV properties will not incur significant additional expenses and therefore costs were not estimated in this report. The economic effects and financial implications of these costs on the sector and individual firms will be analyzed where data are available. Implications for the two salt companies subject to this regulation are examined separately from the metal mines.

The current monitoring regulation has gone through several versions, resulting in a regulation that accommodates government objectives, industry concerns and public representative suggestions. Evidence of the cost-effectiveness of the proposed requirements is revealed by comparing the costs associated with the proposed requirements with potential costs incurred under a more comprehensive across-the- board set of requirements.

This scenario may be interpreted as "equitable" in that all mines have to conduct the same number and kind of analytical tests regardless of the metal mined. These estimates show how much monitoring costs have been reduced by developing requirements which are specific to each product subsector and to each effluent type.

1.5 Cost Estimation Procedure

Incremental costs of monitoring consist of recurring operating and one time capital and installation expenditures. In this report, capital and operating costs have been estimated for each monitoring function at each plant.

Steps involved in cost estimation include the determination of the activities and items that are required to implement each monitoring function and the stated use of simplifying assumptions where necessary.

Cost estimates are based on specifications in the regulations.

With the concurrence of the Ontario Mining Association, the cost of analytical testing was estimated by assuming that all analytical testing would be conducted by a commercial laboratory. This assumption was made in order to obtain comparable cost estimates for each of the mines. In this sector, few mines have the capability of conducting all of the analytical tests in-house. In cases where mines intend to do some or all of the testing in house, the costs for analyses may be overestimated.

Estimates presented in this report provide indications of the magnitude of costs that the sector may incur by complying with the MISA monitoring regulations. Cost estimates for individual mines are uncertain, and should be viewed as bench-marks which may deviate from actual

costs. The greatest degree of uncertainty lies in estimates for flow measurement costs. The OMA indicated that because of the large number of mines, it was very difficult to ascertain what equipment exists at the mines and what additional equipment would be required to comply with the regulations. Also, installation of weirs and flumes are very site specific and are therefore difficult to generalize across the mines.

Cost estimates for the two salt plants, Domtar and Canada Salt Company can be found in section 2.9. Estimates have been derived separately from the metal mines because the salt plants may fulfill the monitoring requirements differently. Cost estimates were obtained directly from the two companies.

Single-valued or point estimates are presented but should be treated with caution because inputs required for different types of monitoring functions are often uncertain. Moreover, there is some flexibility as to how individual mines may implement some of the monitoring requirements.

All cost estimates are expressed in 1988 Canadian dollars.

1.6 Pre-Regulation Consultation and Meetings

Industry representatives from the Group "A" mining sector spent time at meetings and review committees in order to participate in the development of the regulations.

The OMA reported they spent an estimated 880 hours in meetings with the Group "A" Joint Technical Committee (JTC) and its Analytical and Regulation Subcommittees over a 12-month period. In addition, OMA members devoted about 880 hours to complete monitoring tasks while 352 person-hours were involved in regulation writing meetings. In total, approximately 2,112 person-hours were spent for pre-regulation assessments, consultation and meetings.

Participation in these meetings may represent an opportunity cost in terms of time spent away from regular business. According to industry representatives, personnel involved in these meetings earn $60,000 per year. Valued in terms of these gross salary dollars, the cost of pre-regulation consultation and meetings would

be approximately $43,200, not including transportation. Transportation costs for the members to attend meetings in Toronto amounted to $79,500. Additional expenses and consultant fees incurred totalled $256,500. The total cost of pre-regulation monitoring meetings was approximately $329,500.

Pre-Regulation activities were a voluntary aspect of the program. The potential incremental costs of monitoring which are estimated in the next chapter are based on activities required by the Regulation. Pre-Regulation costs are not included in the assessment of the economic implications of the monitoring costs presented in Chapter 3.

2.0 MONITORING COST ESTIMATES

2.1 Regulation Requirements

The General Effluent Monitoring Regulation specifies requirements for five major monitoring activities which each wastewater discharger must implement to various degrees and levels of effort.

1. Sampling requirements
2. Analytical requirements (characterization and routine analyses)
3. Toxicity testing
4. Flow measurement
5. Data reporting including preparation of an "Initial Report"

Four types of sampling points or effluent streams are defined in the specific regulation for this sector.

1. Process effluent
2. Mine-Water effluent
3. Smelter/Refinery effluent
4. Stormwater

As shown in Table 2.1, most mines have only one sampling point to monitor. Mines generally discharge water from two sources: water pumped from the mine and wastewaters pumped to tailings areas. Therefore, at most mines the sampling point is either minewater effluent or the "process effluent".

The process effluent refers to water discharged from an active tailings area at a mining operation. Stormwater effluent refers to water discharged from inactive tailing areas and includes any effluent from parking lots and chemical storage areas.

Monitoring schedules, which specify analytic requirements, for Group A mines differ for each subsector. This has been done to reflect the different processes employed within each subsector and the different contaminant mix generated by them. However, all mines within a subsector are subject to the same monitoring schedule.

TABLE 2.1 NUMBER OF SAMPLING POINTS PER SUBSECTOR EXCLUDING EXPLORATION AND DEVELOPMENT PROPERTIES	
Subsector	# of Sampling Points*
Copper, Lead, Zinc, Nickel	17
Gold	31
Silver	0
Iron	1
Salt	5
Uranium	12
TOTAL	66

Unlike other industrial sectors continuous flow measurement is not required for this sector. Each mine is required to measure or estimate the flow of each effluent stream at the time of sampling, within an accuracy of $\pm$ 20% of the actual flow.

2.2 Sampling Requirements

Sampling protocols and specifications are defined in Section 3 of the "Effluent Monitoring - General" regulation.

Sampling involves traveling to the designated sampling point, collecting samples of the discharged water, storing samples prior to shipment to laboratories and then transporting them to a commercial laboratory for analyses. Samples must be taken for characterization analyses, routine testing and for toxicity tests.

Because of the uncertainty as to how metal mines would fulfill the sampling requirements, two scenarios have been developed. One scenario involves sampling undertaken in-house and the other by consultants.

In-house Sampling - Metal Mines

In this scenario, sampling will consist of both operating and capital expenditures.

Capital costs for sampling include:

- new vehicle, snowmobile (if purchased);
- modifications to facilities and laboratory equipment;
- supplies; and
- refrigerator.

The OMA assumed that each mine would purchase a van, at a cost of $22,000. Because most of the mines are located in northern Ontario, collecting and taking samples becomes more difficult in winter months. Mine operations could either plow the access road to the sampling point or use a snowmobile during the winter months. A snowmobile would result in an additional expenditure of $3,000.

The regulations further require that samples be stored at a temperature no higher than 10°C. The OMA estimated that storage refrigerators would cost $3,000 each, and that each mine would require a new refrigerator. This assumption may result in an over-estimate of the costs if some mines use existing refrigerators to store their samples.

Lastly, modifications to facilities and supplies required would total $3,200 per site.

Estimated capital costs associated with sampling in-house would total $31,200 per site, amounting to $1.6 million for the Group "A" metal mines.

Operating expenditures consist of the following components:

- operation and maintenance of flumes;
- operation and maintenance of a vehicle;
- personnel.

The OMA estimated $7,500 per year for operation and maintenance of a van.

Assuming the mines purchase a snowmobile, additional operation and maintenance expenses will be incurred. The snowmobile is estimated to travel 600 km a year within the mine operation. This estimate is based on traveling 10 km per day, 3 days a week for five months. Using a government rate of $.275 per km, operation and maintenance of a snowmobile would amount to $165 per year.

Operation and maintenance estimates for both the van and snowmobile totals $7,665 per year.

Based on estimates from the OMA, one person-year per metal mine would be required to take samples, measure flows and record data. The annual salary for this individual was estimated to be $40,000. This amounts to 52 person-years at a cost of $2.1 million for the 12 month period. Estimates from other industrial sectors suggest that dedication of one person-year may be an overestimate of the staff requirements for these activities.

Operation and maintenance of the weirs and flumes is required to keep these devices clear of ice in the winter and free from the handiwork of beavers. The OMA estimated that 2 to 8 person-days would be required per flume per year. Valuing the time at $20/hr, operation and flume maintenance ranges from $320 to $1,280 per year.

In total, operating costs for sampling in-house range from $48,000 to $49,000 per year per mine. Costs for individual mines will differ depending on the number of effluent streams that will require sampling. Sampling operating costs for the metal mines totals $2.5 million for the 12 month period.

The total incremental operating and capital costs of in-house sampling totals approximately $4.1 million for the Group "A" metal mines excluding transportation. Figure 2.1 summarizes the capital and operating cost estimates by subsector and Appendix B summarizes these costs by plant. These estimates do not include transportation of samples to laboratories for analytical testing.

Sampling may be contracted to a consultant if the mine management does not have the necessary trained personnel. The consultant would be responsible for collecting and recording the samples and arranging transportation. Transportation costs for the samples will be incurred regardless of which scenario the mine chooses and so will be calculated separately.

Sampling Undertaken By Consultant - Metal Mines

Because there is a limited number of consulting companies in Northern Ontario with the necessary technical expertise, the OMA assumed that the mines

would contract consultants from the Toronto region. Personnel would fly to the mine-sites each week in order to fulfill the sampling requirements.

In this scenario, the capital expenditures include a commercial refrigerator to store samples, and the purchase of a van. Using the OMA's estimate of $3,000 for the refrigerator and $22,000 for a new van, capital costs total $25,000 per mine, amounting to $1.3 million for the Group "A" metal mines.

The OMA estimated that one employee of the consultant would be required 8 hours a day, five days a week for 12 months. At an hourly rate of $45, this amounts to $93,600 for the 12-month period per site. Estimated expenses for accommodations, meals and airport parking for 5 days a week over 12 months are listed below.

Accommodation:	$55 per day
Meals:	$30 per day
Airport Parking:	$10 per day
Airport Mileage:	100 km @ $.25 km
Miscellaneous Expenses:	$10 per day

Vehicle operation and maintenance amounted to $7,500 per year.

Estimates of transportation costs of the consultant were also prepared. Due to the large number of mines in this sector, a typical site was selected from each subsector which represented the median travel distance. The annual air fares for the representative sites are as follows:

Subsector	Return Air Fare	Cost Per Year
Copper, Lead, Zinc	$545	$28,340
Gold	$545	$28,340
Uranium	$320	$16,640
Iron	$386	$20,007

These transportation costs will understate the actual costs for some mines and overstate them for others. Moreover, if consultants obtained fare discounts, actual transportation costs may be somewhat less than these estimates. These costs do not include the costs of transporting the samples for laboratory testing.

Total annual operating costs for sampling by a consultant range from $144,000 to $158,000 per mine-site, and total $8.1 million for the Group "A" metal mines.

The total costs for sampling if undertaken by a consultant amounts to $9.4 million for the 12-month period.

The estimated costs for sampling for each scenario are summarized by subsector in Figure 2.1.

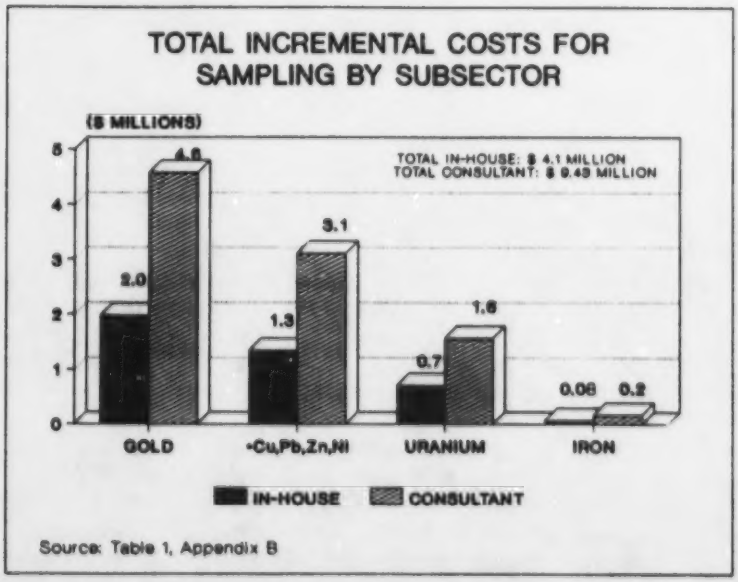
The total cost of sampling for the Group "A" metal mines would be approximately $4.1 million if undertaken in-house and $9.4 million if undertaken by a consultant. Sampling by a consultant would cost $5.3 million more than if the activity were carried out internally.

If personnel are available both within the mine and in neighbouring communities, the least-cost option for the mine is to undertake sampling internally.

Sampling will be carried out in-house by some mines and by consultants for others. Therefore, these two sets of estimates provide a range for the actual sampling costs.

Sampling costs for the two salt plants are derived in Section 2.9.

Figure 2.1



2.3 Analytical Testing, Characterization

Analytical testing includes routine analyses, characterization, open characterization and fish toxicity testing. In this section estimates of characterization costs are presented.

The priority pollutants assigned for monitoring of effluents in Group "A" were taken from the Ontario Effluent Monitoring Priority Pollutants List (1987) (EMPPL).

The EMPPL includes chemicals detected in Ontario municipal and industrial effluents and Ontario's waterways which pose a hazard to the receiving environment because of their toxicity and persistence. The EMPPL currently includes 179 chemicals.

Table 2.2 lists the analytical test groups and their prices that are to be tested under the Group "A" regulations.

Monitoring will be also carried out for substances that are somewhat specific to Group "A" mines. These include chlorides, cyanates, thiocynates, iron, uranium and weak dissociable cyanides.

Some test groups, such as Groups 4a, 4b include many specific chemicals. However, the laboratory price given is for a complete analysis of the entire group no matter how many compounds in the group actually need testing. Using these prices in cost estimation results in an over-estimation of analytical costs.

Prices of laboratory tests include quality assurance/quality control (QA/QC) samples and the preparation of required reports, but does not include transportation of samples from the mines to laboratories.

The regulation allows for the samples taken thrice weekly and monthly as required by routine sampling to be used towards characterization analyses. The following cost estimates for characterization reflect this provision.

Characterization analyses requirements are specified in Section 7 of the "Effluent Monitoring - Ontario Mineral Industry: Group "A" regulation". Characterization involves infrequent testing of a small number of analytical test groups.

TABLE 2.2

LABORATORY TEST PRICES FOR ANALYTICAL TEST GROUPS

No.	Analytical Test Group	Price ($) Average
1.	Chemical Oxygen Demand	29.78
2.	Cyanide	36.10
3.	Hydrogen Ion (pH)	6.84
4a.	Amonia Nitrogen plus amonium Total Kjeldahl Nitrogen.	
4b.	Nitrate	86.99
5.	Organic Carbon	57.03
6.	Total Phosphorus	25.12
7.	Conductivity	9.44
8.	Total Suspended Solids (SS) Volatils Suspended Solids (VSS)	14.87
9.	Metals (13 metals)	84.10
10.	Hydrides (Arsenic only)	23.33
11.	Chromium (Hexavalent)	20.47
12.	Mercury	25.77
13.	Total Alkyl Lead	172.00
14.	Phenolics (4AAP)	42.93
15.	Sulphide	30.00
16.	Volatiles, Halogenated	239.90
17.	Volatiles, Non-Halogenated	176.81
18.	Volatiles, Water Soluble	126.50

TABLE 2.2 (Continued)

LABORATORY TEST PRICES FOR ANALYTICAL TEST GROUPS

No.	Analytical Test Group	Price ($) Average
19.	Extractables, Base Neutral	427.49
20.	Extractables, Acid (Phenolics)	245.68
21.	Extractables, Phenoxy Acid Herbicides	188.09
22.	Extractables, Organochlorine Pesticides	270.14
23.	Extractables, Neutral Chlorinated	232.04
24.	PCDDs & PCDFs	1,228.27
25.	Oil & Grease	36.00
26.	Fatty Acids & Resins	133.18
27.	PCBs (Total)	103.90
28a/b	Open Characterization, Volatile and Extractables	500.00
29.	Open Characterization, Elemental	300.00

Source: Inventory and Critical Review of Laboratory Resources, Toronto. Laboratory Services Branch, Ontario Ministry of the Environment, 1988.

Each effluent stream will be characterized quarterly for the analytical test groups specified in the regulation. This includes testing of PCB's and analysis of dioxins. All effluents will be characterized for dioxins once during the 12 month period, and PCBs quarterly for mines where PCB's are stored. If analysis of dioxins was undertaken in pre-regulation analyses it need not be repeated.

The salt subsector will characterize minewater effluents twice a year, because of the very small effluent volumes involved and the routine nature of the effluent (saturated brine).

Open characterization is also required in conjunction with characterization analyses. Open characterizaton will provide identification of organic compounds and elements and will be used to provide identification of compounds which could potentially be added to the EMPPL.

Total annual characterization costs range from $16,000 in the iron subsector to $474,670 in the gold sector for a total of $909,000 per year for the Group "A" metal mines. Figure 2.2 presents a summary of characterization analyses costs per subsector, (excluding salt). Appendix B summarizes these costs by plant. Analytical costs for the salt subsector are summarized in section 2.9.

These estimates do not include Pre-Regulation characterization analyses. Pre-Regulation monitoring is not required by the Regulations, but was an important aspect of the regulation development process.

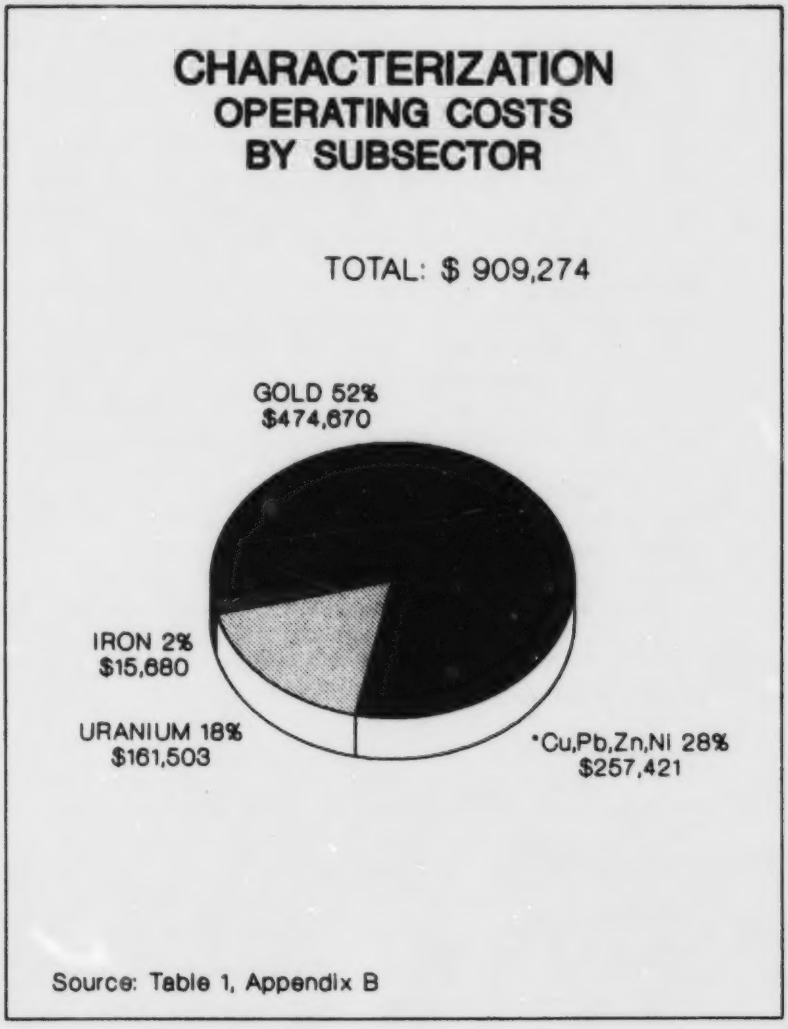
2.4 Routine Analyses

Routine analyses in this sector involve testing of samples which are taken at two frequency levels - three times per week, and monthly, plus on an event basis for certain sampling points such as stormwater effluent.

Parameters assigned for routine testing are those that historically have been subject to control either at provincial or federal levels.

The cost of routine analyses vary substantially from one subsector to another due to differing testing requirements. However, the costs incurred

Figure 2.2


CHARACTERIZATION
OPERATING COSTS
BY SUBSECTOR
TOTAL: $ 909,274
GOLD 52%
$474,670
IRON 2%
$15,680
URANIUM 18%
$161,503
*Cu,Pb,Zn,Ni 28%
$257,421
Source: Table 1, Appendix B

by individual mines within a subsector differ slightly. This occurs because most mines only collect samples for one effluent stream.

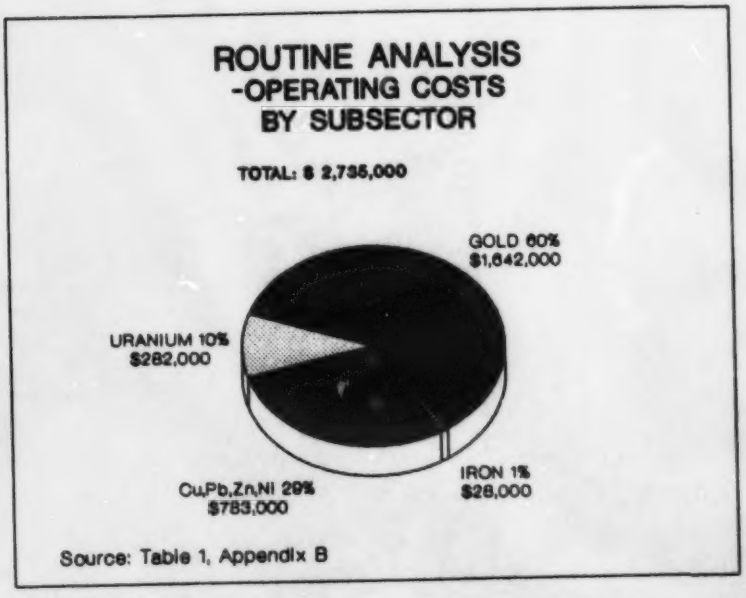
In the gold sector, mines with production below 1,000 tonnes per day are required to monitor for copper, lead, nickel, zinc and arsenic monthly instead of thrice weekly as required for larger companies.

The annual cost for these tests is approximately $1,300 when tested monthly, compared with $16,700 when tested thrice weekly. However, due to limited production data, the following cost estimates do not take into consideration this provision. All mines have been treated identically and the estimates reflect testing the above noted chemicals thrice weekly.

The annual operating cost of routine analyses ranges between $15,800 and $53,400 per mine. The total point estimate for all metal mines excluding EXP/DEV status mines and the salt plants amounts to $2,735,000 for the 12-month period. Routine analyses involve no capital costs.

Details of the estimated routine analyses cost for each subsector, excluding transportation, are shown in Figure 2.3, below. For the estimated costs by plant see Appendix B.

Figure 2.3



2.5 Toxicity Testing

Toxicity testing consists of the static 96-hour rainbow trout toxicity test and a 48-hour Daphnia magna (a small invertebrate crustacean) mortality (acute lethality toxicity) test.

Each effluent stream will be tested quarterly.

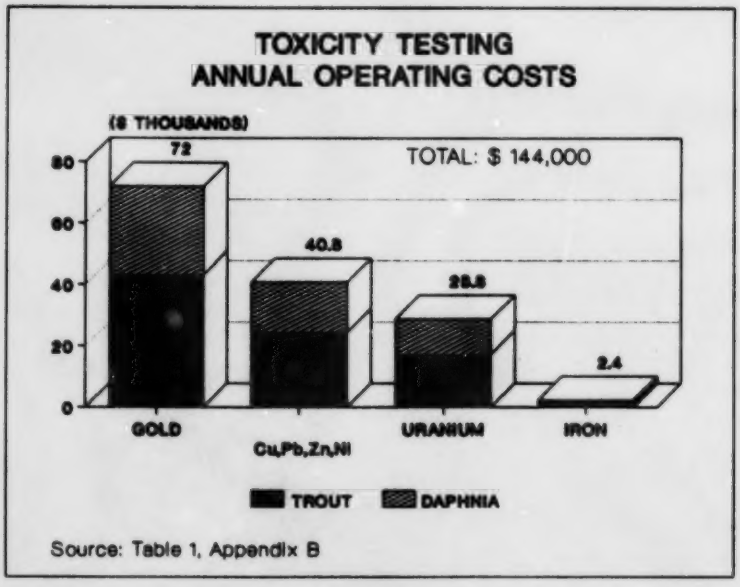
Toxicity testing costs are based on the following commercial prices:

Trout:	$360 per test
Daphnia:	$240 per test
	$600 per test

These prices do not include costs of collecting the samples or transport to the laboratory.

Using these prices, the total cost of this function during the 12-month period amounts to $144,000 for the Group "A" metal mines as shown in Figure 2.4 below. Appendix B presents these estimated costs by plant.

Figure 2.4



2.6 Transportation of Samples

Estimated transportation costs provided by the OMA were based on the median distance from a representative property in each subsector to Toronto.

Numbers of samples which would require "same day" shipment because of short holding times were calculated. Samples with longer allowable holding times were considered to be "bulked" into weekly, bi-weekly, monthly and quarterly shipments in order to minimize shipping costs. Estimated tariffs for an overnight courier, as well as for a "two day" refrigerated freight service from each representative site to Toronto were obtained. These estimated costs were then applied to all properties within the given subsector to obtain an estimated total. Based on these assumptions, it is estimated that the costs for sample transportation may be approximately $222,000 for the Group "A" metal mines. Estimated transportation costs per year per subsector are presented below.

Subsector	Cost Per Year
Base Metals	$ 73,661
Gold	113,775
Iron	4,334
Uranium	30,528
	$222,298

2.7 Flow Measurement

Each mine is required to measure or estimate the flow of each effluent stream at the time of sampling, within an accuracy of ± 20%.

Continuous flow measurement is not required due to the long retention time and constant flow rates of the effluent and the mechanical difficulties of monitoring remote points year-round.

Less than 10 percent of Group "A" metal mines have any type of flow measuring devices, such as weirs, installed at their effluent sampling points.

For those mines that do not have existing equipment, the OMA assumed that a "parshall flume" would be installed in a ditch at each effluent stream. Sizes and costs associated with installation of flumes will depend on flow volume.

Because flow data were not available for most of the metal mines, cost estimates were based on an assumed direct relationship between ore production and flow volume. The more tonnage produced, the greater the flow and hence the need for larger flumes. Escavation, concrete and access road construction costs were estimated by the OMA to range from $19,000 to $70,000 per installation.

For stormwater and minewater effluents, regardless of the amount of ore produced, a standard sized parshall flume was assumed. The OMA estimated $20,000 for installation of this type of flume.

For mines that have existing flumes or weirs, capital costs include calibration of the existing equipment. Calibration costs tend to be site-specific and are, therefore, very uncertain. Because of these uncertainties the OMA suggested a range of between $5,000 and $15,000 per flume for calibration.

Total capital costs for flow measurement range from $.9 to $3.2 million for Group "A" the metal mines.

Estimated operating costs are based on two to eight person-days per year per flume for operation and maintenance. At $20 per hour, this amounts to a total of between $17,700 to $78,000 for the Group metal mines.

Total incremental capital and operating costs for flow measurement range between $1.0 to $3.2 million for the Group "A" metal mines.

Table 2.3 and Table 2.4 summarize both capital and operating costs for flow measurement by subsector. Appendix B summarizes flow measurement costs by plant.

2.8 Reporting

Reporting consists of two major tasks: development of an "initial report" to the Ministry which details production and wastewater flow diagrams, sampling and testing procedures and analytical facilities to be used; and the assembly, entry, storage and reporting of monitoring data to company management and to the Ministry.

TABLE 2.3

ANNUAL OPERATING COSTS
FLOW MEASUREMENT
($'000)

Subsector	Low	High
Gold	9.0	39.0
Iron	.03	1.3
Uranium	3.6	15.6
Copper, Lead, Zinc, Nickel	5.1	22.1
TOTAL	17.7	78

TABLE 2.4

CAPITAL COSTS
FLOW MEASUREMENT
($'000)

Subsector	Low	High
Gold	532	1,850
Iron	20	70
Uranium	193	535
Copper, Lead, Zinc, Nickel	201	695
TOTAL	946	3,150

Based on the drafting and reporting preparation functions required by the General Regulation the OMA estimated that the initial report would cost $10,800 per effluent stream. Additional effluent streams would result in a cost of $2,700 per stream.

The following is a breakdown of the components of these costs:

Drafting:	60 person-hours @ 30/hr
Report Preparation:	160 person-hours @ 50/hr
Clerical:	30 person-hours @ 25/hr

The initial report may cost approximately $625,200 for the Group "A" metal mines. These costs have been considered operating expenditures.

Data storage and manipulation will require an AT personal computer together with compatible peripherals and software, plus personnel dedicated to perform report generation functions.

The OMA indicated that all metal mines would purchase the computer hardware and software necessary to comply with the regulation. Based on a cost of 10,000 per computer per mine, capital costs of reporting total $520,000 for Group "A" metal mines.

Because of unavailable technical personnel, the OMA felt that smaller mines, perhaps those producing 400 tonnes per day or less, would hire a consultant to input data. It was estimated that contracting these services may cost approximately $2,000 per month. However, due to incomplete data on tonnage per day, it was not possible to estimate the cost for all of the smaller mines. Therefore, these estimates may overstate the actual costs for the Group "A" metal mines. Where data was unavailable it was assumed that the mine would engage in reporting internally.

It is assumed that 4 person-hours per day of clerical time would be required to input the monitoring data. At a rate of $25 per hour, operating costs would be $37,700 per mine for the 12 month period. Total incremental operating costs amount to $1.9 million for Group "A" metal mines.

The total estimated operating and capital cost of the initial report and reporting amounts to approximately $2.4 million for the Group "A" metal mines for the one year period of the monitoring regulation.

2.9 Monitoring Costs for Salt Producers

Two salt plants are included in the Mineral Group "A" sector.

One of the plants is located in Windsor and is owned and operated by the Canadian Salt Company (CSC), a wholly-owned subsidiary of Morton Thiokol Inc. An evaporation plant is associated with the CSC salt mine and is also subject to the monitoring regulations. These two establishments have 3 effluents or sampling points between them.

The other salt plant is operated by the Domtar Chemicals Group, and is located near Goderich. The salt mine has two sampling points specified under the regulation.

Unlike the metal mines, cost information was obtained directly from the two companies. Scenarios for sampling were not analyzed because the two salt companies indicated sampling would be conducted on-site by plant personnel.

Table 2.5 summarizes the operating and capital costs by monitoring function.

The total operating and capital costs for monitoring as estimated by the companies amounts to $192,000 for Canadian Salt Company (CSC) and $196,000 for Domtar totalling $388,000 for the salt subsector.

Sampling activities totalled approximately $107,000 for the sector and consisted of both capital and operating expenditures. Estimated costs for sampling range from $31,556 for CSC to $75,787 for Domtar. The variation in these costs is due primarily to differences in capital equipment required by each company. CSC indicated that their existing vehicle and refrigeration equipment would accommodate the monitoring requirements and that, if grab samples are allowed, automatic samplers would not be needed. Domtar reported that two automatic samplers were required at a cost of $22,000 each including installation but that additional refrigeration equipment would not be necessary. Operating costs for sampling amounted to about $32,000 for each company.

Table 2.5

ESTIMATED INCREMENTAL COSTS OF MONITORING
AVERAGE LABORATORY PRICES
SALT SUBSECTOR
(1989 dollars)

ACTIVITY	Canadian Salt Co. Windsor	Domtar Goderich	Total
Number of Sampling Points	3	2	5
SAMPLING			
Capital			
Equipment and Installation (1)	0	44,000	44,000
Operating			
Operation and Maintenance	29,996	17,787	47,783
Vehicle Maintenance	0	3000	3,000
Transportation of samples	1,560	11,000	12,560
Total	31,556	31,787	63,343
Total Sampling	31,556	75,787	107,343
FLOW MEASUREMENT			
Capital			
Equipment and Installation (2)	60,000	5,000	65,000
Operating			
Operation and Maintenance (3)	10,000	0	10,000
Total Flow Measurement	70,000	5,000	75,000
ANALYTICAL TESTING			
Operating Costs			
Characterization Analyses	24,288	16,240	40,528
Routine Analyses	51,619	34,268	85,887
Toxicity Testing	7,200	4,800	12,000
Total Analytical Testing	83,107	55,308	138,415
REPORTING AND ADMINISTRATION			
Capital	0	10,000	10,000
Operating	7,500	49,468	56,968
Total Reporting and Admin.	7,500	59,468	66,968
Total Operating Costs	132,163	136,563	268,726
Total Capital Costs	60,000	59,000	119,000
TOTAL	192,163	195,563	387,726

Source: Company estimates

Notes:
(1) This assumes that grab samples are allowed and therefore, automatic samplers are not reqired.
(2) If the estimates obtained from the existing pump meet the reqirements than additional expenditure is not required. If the accuracy required is more stringent than +- 10% than the cost is $30,000 per outlet for a total of $60,000.
(3) For both firms flow measurement will be taken by the staff that does the sampling.

The estimates reported by Domtar are based on locating the evaporation plant sampling point on the plant site above the settling pond. However, if Domtar is required to sample below the settling pond the costs associated with monitoring would increase significantly. Installation of both the flow measurement and sampling equipment would increase to $35,000, winter snow plowing would be required at a cost of between $3,000 and $5,000 and it would take between six and 10 hours to obtain each sample as opposed to one to two hours. In addition, the town sewage treatment plant effluent enters the settling pond so that contaminants found at the would not originate solely from Domtar.

Total costs for flow measurement are estimated at $5,000 for Domtar and $70,000 for CSC and consist primarily of capital expenditures. The capital expenditure reported by CSC may not be required if the existing pump accuracy of +/- 10% is acceptable. For Domtar only a flow meter at the mine is required at a cost of $5,000. The only operating costs for flow measurement are maintenance costs of $10,000 annually for CSC if the flow equipment is required. The sampling staff will take flow measurements so that additional personnel would not be required.

Analytical testing totalled $83,000 for CSC and $55,000 for Domtar. Table 2.5 shows the breakdown for characterization, routine and toxicity.

The costs reported for transportation of the samples to a laboratory varied substantially between the two companies. CSC based their estimated on $130 per shipment for a total of $1,560 or the year. Domtar's preliminary estimates amount to $6,000 for the mine and $5,000 for the plant for a total of $11,000.

Reporting consists of both completing an initial report and various reports on the monitoring data. CSC estimated that the initial report would cost between $5,000 and $10,000 in personnel time but did not report any expenditures for the other reporting activities.

Domtar estimated that the initial report would cost approximately $3,000 per site or $6,000 in total. The other reporting functions consist of both capital and operating costs. The only capital expenditure that was reported was a computer at a cost of $10,000. Operating costs included training of personnel, and personnel required for data

input. Domtar estimated that data input would require 15 hours a week per site of personnel time. Valued at $25 per hour this totals just over $39,000 for the two sites. Operating costs for reporting amounted to approximately $49,000 for Domtar. The total costs for reporting were estimated at $59,500 for Domtar and approximately $7,500 for CSC, amounting to $67,000 for the salt subsector.

2.10 Total Estimated Costs of the MISA Mineral Group "A" Sector Monitoring Requirements

The total average incremental capital costs of compliance are estimated to range from $3.9 million under the consultant sampling to $4.4 million if the mine conducts sampling in-house.

- Capital costs have some uncertainty attached to them and could vary depending on individual mines requirements for flow measurement.

Incremental operating costs for the sector over the 12-month period range from $8.7 million under the mine sampling scenario to $14.1 million if consultants undertake sampling.

The total incremental cost of complying with the MISA Monitoring Regulation for the Group "A" sector ranges from $13.1 to $18.0 million, and is summarized in Table 2.6.

The upper estimate reflects the total costs associated with contracting a consultant to undertake sampling, while the lower estimate is based on in-house sampling by mine personnel.

If personnel are available both within the mine area and in neighbouring communities, the least cost option for the mine is to undertake sampling internally.

Sampling will be carried out by mine personnel at some plants and by consultants for others. Therefore, the actual total costs for monitoring is likely to be within this range of estimates.

Average total capital and operating costs by monitoring activity and by sampling scenario are summarized in Figure 2.5.

Table 2.6

PRELIMINARY ESTIMATES OF THE INCREMENTAL AVERAGE OPERATING AND CAPITAL COSTS BY SUBSECTOR AND SAMPLING SCENARIO
('000 $1988)

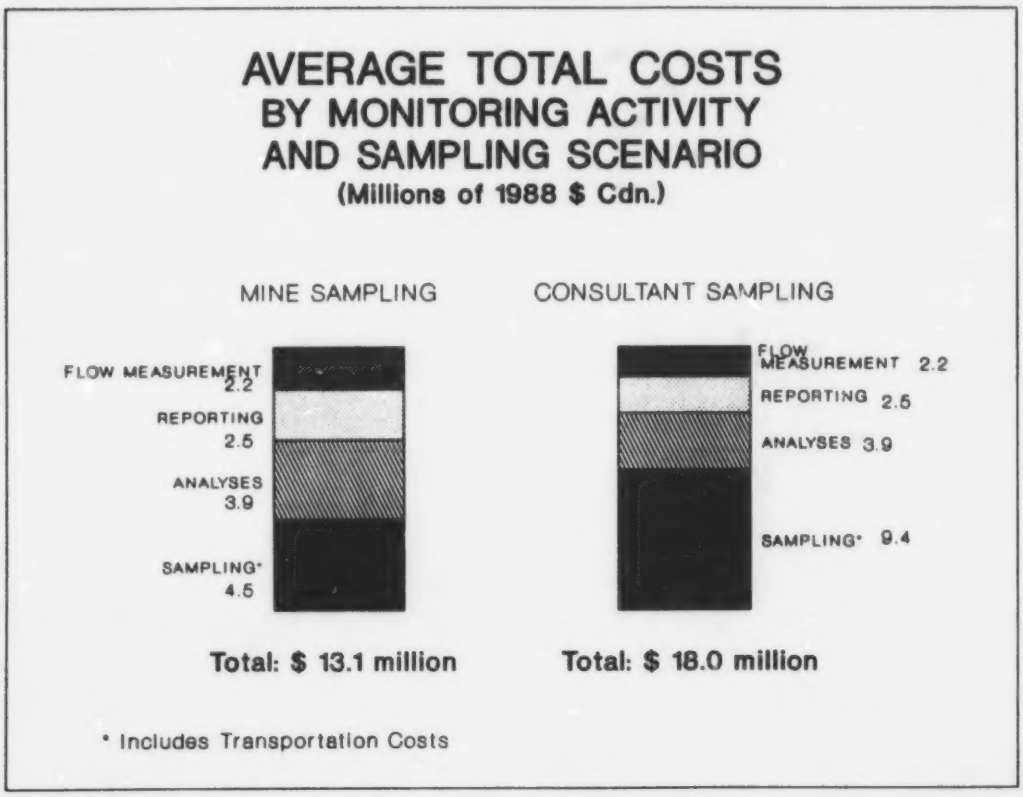
	MINE SAMPLING			CONSULTANT SAMPLING		
SUBSECTOR	Operating	Capital	Total	Operating	Capital	Total
GOLD	4,417	2,221	6,638	7,165	2,066	9,231
IRON	137	86	223	239	80	319
SILVER	0	0	0	0	0	0
URANIUM	1,259	805	2,064	2,168	749	2,917
SALT	276	87	363	0	0	0
COPPER, LEAD	2,622	1,148	3,771	4,496	1,043	5,539
TOTAL	8,712	4,347	13,059	14,067	3,938	18,005

Source :Table 1, Appendix B

Total incremental costs for sampling including transportation represent the largest expenditure for both scenarios ranging from $4.5 million under the mine sampling scenario to $9.4 million if consultants undertake sampling. Estimates for the other monitoring activities are the same for both scenarios.

- Analytical testing amounts to $3.9 million, reporting $2.5 million and flow measurement $2.2 million.

Figure 2.5



2.11 Alternative Estimates of Routine Monitoring Costs

The Group "A" Monitoring Regulation specifies different testing requirements for each subsector. If, however, the same parameters were tested at the same frequency in all mines, the cost burdens would differ. This scenario could be viewed as more "equitable", in that all mines would be subject to the same generic testing schedule.

An alternative set of routine analyses costs were estimated for this "equitable" scenario in order to illustrate the cost effectiveness of having requirements specific to each subsector and effluent stream. The following assumption was used:

- The Group "A" mines subject to the MISA regulations would have to monitor all effluent streams thrice weekly for the maximum number of contaminants specified in the regulation. Therefore all mines will test for the same chemicals at the same frequency regardless of the mineral mined.

The implications of this scenario for other monitoring functions were not calculated because the requirements and costs for these activities would change only slightly. The largest difference would occur in routine analyses which are estimated below.

This baseline scenario would result in routine analyses costs of $77,000 per sampling point, with a point estimate of $5.1 million for the entire Group "A" sector. This compares to the total estimated routine analyses costs, of the proposed regulation of $2.8 million.

As shown in Table 2.7, the subsector-specific requirements under the proposed regulation is estimated to cost $2.3 million less than the "equitable" scenario. This difference is a measure of the cost-effectiveness of the analytical schedules specified for the Group "A" sector. The MOE has been cognizant of the potential financial implications of the MISA requirements and has incorporated such considerations in the development of the monitoring regulations.

TABLE 2.7

ALTERNATIVE ROUTINE ANALYSES COST ESTIMATE ($'000)

SUBSECTOR	PROPOSED	EQUITABLE	DIFFERENCE	% INCREASE
Gold	1,642	2,387	2,147	131%
Iron	28	77	49	175%
Uranium	282	924	642	227%
Copper, Lead, Zinc, Nickel	783	1,309	526	67%
Salt	86	385	299	347%
TOTAL	2,821	5,082	2,261	80%

3.0 ECONOMIC EFFECTS AND IMPLICATIONS OF MONITORING COSTS

3.1 Industry Structure and Outlook

Mining is a major contributor to employment and income in Ontario's north. The value of all mineral production in the province was $5.6 billion in 1987 (ARA, 1988). The value of production of the 8 metals of concern to MISA was $3.8 billion or 68% of total mineral production in Ontario in 1987. As Table 1 in Appendix C illustrates, the mining operations under review employed up to 28,000 workers in 1987. (Canadian Mines Handbook, 1988).

The markets for nickel, copper, lead, zinc, iron, gold and silver under review are generally considered competitive internationally. Prices for the base metals are based on the London Metal Exchange. Gold and silver are traded on all world markets.

The market for uranium, is not considered to be perfectly competitive as there are few sellers and, even fewer buyers. The uranium market in Ontario is characterized by two sellers, Rio Algom and Denison Mines, and one principal buyer Ontario Hydro. Prices are set in long term contractual agreements (ARA, 1988).

The domestic zinc market can be characterized as oligopolistic; Cominco and Noranda are the only zinc producers in Canada. However, their control on prices is limited because they deal in a North American and International market. Competition from the United States ensures that the prices set by all producers in North America are similar.

Iron ore produced in Ontario is seldom traded on open markets. Demand for iron ore is derived from world demand for steel. The producers of iron ore, Dofasco and Algoma Steel Corp., are both integrated steel producers so that most of iron ore produced is sent directly to their steel operations (ARA, 1988). However, because the high costs of producing ore in Ontario, Dofasco is planning to shut down both its Sherman and Adams iron ore mines sometime in 1990.

Mining is characterized by boom and bust cycles which drastically alter the outlook for producers from year to year. As noted above, the Canadian and Ontario metal industry is heavily dependent upon international markets. During the eighties,

domestic producers lost market shares to new sources of production, many of which are located in less developed countries. Some of these producers sell at below cost to obtain foreign exchange, thus contributing to excess capacity for some metals. These factors together with decreased demand resulted in depressed prices for most metals. In response to these conditions, Canadian metal producers underwent significant restructuring, cost cutting and rationalization (ARA, 1988).

Mining operations that produce copper, lead, zinc and nickel face differing outlooks according to the metal produced. The long term outlook of lower prices for copper, lead and nickel will be offset to some degree by the strong zinc prices. Because zinc is used to galvanize steel, zinc prices are expected to remain strong so long as the demand for steel continues to increase (ARA, 1988).

The price of uranium is expected to remain steady. Although world uranium markets are suffering from excess capacity, long term contracts with Ontario Hydro will shelter Ontario producers from price depression to some extent.

Gold prices are particularly difficult to predict. The price of gold is not only dependent on supply considerations but on political events, the strength of global economics and such macroeconomic issues as inflation. Oversupply has depressed gold prices throughout the 1980's causing a steady decline in prices. Gold markets are experiencing further pressures from new gold mines coming into production in Ontario and elsewhere (ARA, 1988).

The silver industry in Ontario may be faced with a decline in demand if new developments in the camera industry materialize. Research is currently underway which would replace photographic film with magnetic tape. Close to half the demand for silver is from film-makers (Globe and Mail, April 12, 1989).

Moreover, silver mines are finding it increasingly difficult to compete with low cost base metal producers that mine silver as a by-product. These base metal producers are now supplying 70% of silver demanded. Agnico-Eagle Mines, which owns silver mines in the Colbat district, has suspended its operations. Experts suggest that the price of silver would have to climb to above $10(U.S.) an ounce before these mines would reopen (presently at 5.35 U.S./oz).

Finally, termination of the "flow-through shares" system in 1988 may affect the ability of some firms to raise financing in the future.

Procedures for evaluating financial and economic impacts of monitoring costs are presented in the next section.

3.2 Analytical Procedures

In this section, some of the key effects of the incremental monitoring costs on the Mineral Group "A" sector as a whole, and on individual firms within the sector, will be examined.

Monitoring costs incurred by the firms under the MISA regulations will increase operating expenses and, unless there is some offsetting increase in productivity associated with wastestream monitoring, profits to the firms and returns on particular plants will be reduced. In this section, economic effects of the monitoring costs on the industry, and on those firms for which financial data are available, will be examined.

Ideally, the impacts of the incremental costs of monitoring should be analyzed against the projected future values of relevant financial measures. However, because such projections are unavailable, the approach taken in this analysis will be to estimate how the appropriate incremental monitoring costs would affect historic after-tax profits, capital expenditures, the return on total assets, and the return on capital employed by each firm. The analyses will show how the monitoring costs would have changed each firm's performance measures if they had been incurred during the worst year, the best year, and an average year over the period of 1983-1987 for which relevant data are available.

Plant-specific financial data are seldom available, although it is at this level that financial consequences affect the viability of an operation and influence decisions. Assessments and comparisons will generally have to be made using consolidated company data which are publicly available.

Financial data have been assembled for 17 companies whose shares are publicly traded. These companies operate 45 of the Group "A" plants subject to the MISA Monitoring Regulation. Financial data was not

available for the remaining 23 plants. These plants are mostly gold mining operations. Assessments of the implications of the MISA Monitoring costs have been made only for these companies.

Performance Measures

One analytical approach involves calculating the ratio of operating costs of monitoring to after-tax profits (net income). This ratio indicates the proportion of after-tax profits, assuming that the firm was unable to pass on any of the monitoring costs as increased prices, that would have to be diverted to monitoring activities. This calculation yields an over-estimate of the effect because operating costs of monitoring are not reduced by the corporate tax rate.

Where long term investment decisions are concerned, a key economic variable is the rate of return on investment or capital employed. This is the return that provides the incentive for owners and investors to remain in a particular enterprise or, move on to something else. In this study, the Statistics Canada definition of return on capital employed was used in which the ratio is equal to:

$$\frac{\text{net income - extraordinary items + interest}}{\text{total assets - current liabilities}}$$

The rate of return on total assets corresponds to the operating profit margin. It measures the effectiveness with which the firm's assets are deployed in order to earn a profit. The ratio is defined by Statistics Canada to be:

$$\frac{\text{net income + interest}}{\text{total assets}}$$

Consequently, the second analysis will show how the potentially recurring operating costs of monitoring would have affected the rates of return on capital employed and total assets for individual firms for which financial data are available. For this analyses, operating costs were reduced by a corporate tax rate of 47%.

A third analytical procedure was carried out to determine the extent to which capital requirements for monitoring would divert capital expenditures away from other uses. Estimated capital costs of

monitoring were thus computed as a percent of total capital expenditures for each firm in each year which capital expenditure data are available.

There is no rule of thumb as to what proportion of capital expenditures should be devoted to environmental protection in any given year. Some industrial representatives assert that a minimum capital expenditure is necessary to carry out a sufficient amount of repair and replacement in order to keep a plant running. These basic expenditures apparently vary from industry to industry and from firm to firm.

This comparison of expected capital expenditures to actual outlays is conservative in that it over-estimates the potential diversion of funds in a given year. Environmental capital expenditures can be fully deducted against income over a three year period at the rate of 25%, 50%, and 75%. Therefore, the reduction to income in a single year would be less than the full amount of capital expenditure that is used in this analysis.

International competitiveness of Ontario mining companies may be affected to the extent that they are unable to pass on cost increases to their customers. Moreover, this issue is of concern only to producers of internationally competitive commodities such as gold, silver, nickel, lead, zinc and copper.

These analyses are by no means definitive, but they can identify those firms which could experience financial effects that are large relative to:

(a) their own historical performance,
(b) other firms' performance in the same industry, and/or
(c) industry performance.

Furthermore, while it would be ideal to assess the consequences of increased costs of individual plants, assessments at the level of the firm are better than no information at all.

Finally, where a company believes that it will suffer financial burdens by complying with environmental requirements, it may request a detailed financial analysis under provisions of the Ministry's Policy and Procedures Manual (Policy 02-01). Plant-specific analyses would remain confidential under the provisions of The Ontario Freedom of Information Act.

3.3 Financial Implications of the Monitoring Regulation

Prices and demand for metallic minerals are cyclical so that the financial performance of metal mining firms have widely fluctuated with business cycles over the past ten years. Sales and prices were depressed for many firms in the industry during the recession of the early 1980's, so that profits and other performance indicators have only recently begun to recover.

Economic recovery in late 1986 and through 1987 pushed producers of nickel, gold and uranium, such as Inco, Rio Algom, Falconbridge, Placer-Dome, Denison and Noranda, into the top ten mining firms Canada in terms of sales or operating revenues (ARA, 1988).

Data on after-tax profits shown in Table 3.1 reflect this recent recovery. This Table also shows those firms which are currently operating with after-tax losses.

Inco experienced the largest single increase in after-tax profits, rising from $177,000 in 1986 to $125,241,000 in 1987. Belmoral Mines, Giant Yellowknife Mines, LAC Minerals, and Noranda all recorded increases in after-tax profits of over one hundred percent in profits from 1986 to 1987. In 1987, Algoma Steel's after-tax profits increased approximately 130% over 1986. This was the first year that Algoma has made a profit since 1981 (Financial Post Information Service, 1988).

After-tax profit over several years is one indicator of the health of a company and an industry. Table 3.1 shows that most of the mining companies had positive after-tax profits in 1987. For the two salt companies Canadian Salt and Domtar financial data was available only from 1983-1985. After-tax profits were positive over these years for both salt companies averaging $9.0 million for CSC and $80 million for Domtar.

Three gold mining operations, Canamax Resources Inc., Muscocho Explorations Limited, and St. Andrew Goldfields reported losses of $16, $3, and $.09 million in 1987 respectively. Canamax experienced consecutive annual losses since 1983, while Muscocho sustained losses since 1984.

These three companies are in the process of bringing properties into production. By the end of 1989, Canamax expects to have 4 gold mines in operation with the ability to produce 100,000 ounces of gold by 1990. St. Andrew Goldfields expects its Stock Township property to also come into production by 1989, (Annual Company Reports, 1987).

Both the Magino and Magnacon properties owned by Muscocho Explorations have begun production in 1988-89. Exploration is being carried out at the Jerome property which will add to their gold reserves. These properties have the proven reserves to produce over 80,000 ounces of gold per year, (Annual Company Report, 1987).

In sum, although these three companies posted losses in recent years, returns are expected in the upcoming year as the new mines come into production.

Table 3.1

Annual After- Tax Profits
($ 000's)

FIRM	1983	1984	1985	1986	1987	Average
Algoma Steel Corp.	(126,646)	(45,706)	(2,975)	(134,845)	40,251	(53,984)
American Barrick Resources Corp.	(4,421)	(16,094)	(22,369)	15,062	24,461	(672)
Canadian Salt Company	10,075	8,961	10,472	N/A	N/A	9,836
Canamax Resources Inc.	(1,051)	(5,448)	(5,148)	(13,893)	(16,127)	(8,333)
Denison Mines Ltd.	101,520	80,516	(157,900)	44,632	27,259	19,205
Dickenson Mines Limited	3,610	2,747	1,720	4,590	6,438	3,821
Domtar Inc. (Salt)	38,100	90,500	110,400	N/A	N/A	79,667
Falconbridge Ltd.	(3,542)	80,186	38,543	70,269	73,120	51,715
Giant Yellowknife Mines Ltd.	4,209	1,891	5,690	3,846	12,256	5,578
Inco Ltd.	(234,894)	(77,343)	52,212	177	125,241	(26,921)
Lac Minerals Ltd.	27,969	29,307	10,629	(21,203)	38,653	17,071
Minnova Inc.	(39)	891	185	4,652	3,257	1,789
Muscocho Explorations Ltd.	145	(91)	475	(152)	(317)	12
Noranda Inc.	(34,599)	(4,451)	(253,873)	43,346	343,471	18,779
Placer Dome Inc.	29,258	29,363	35,312	93,900	158,200	69,207
Rio Algom Ltd	51,140	73,887	88,348	70,182	93,075	75,326
St. Andrews Goldfields Ltd.	436	477	254	183	(94)	251
Total	(138,730)	249,593	(88,025)	180,746	929,144	262,347

Source: Financial Post Information Service, 1988

Table 3.2 summarizes the impacts of monitoring costs on after-tax profits and capital expenditures for the worst, best and average year during the period 1983-1987.

For nine companies, monitoring operating costs represent less than 4% of average annual after- tax profits for the period. These companies are mainly large, diverse enterprises.

For the year in which profits were at their lowest, monitoring operating costs would have represented between .1% to 26.7% of after-tax profits (or losses) for these nine companies. Operating costs of monitoring would have accounted for between .1% and 6.3% for the year when profits were at their highest during the period.

For companies which incurred either very small losses or profits during the period, monitoring costs had the largest impact and represented over 100% of after-tax profits. This is the case for two gold mines, Muscocho Explorations and St. Andrews Goldfields Ltd., and two base metal producers Minnova Inc. and Inco. Monitoring operating costs would have represented between 190% and 1,333% of after-tax earnings for the year in which these companies' profits were at their lowest. For the best year during the period, the percentages drop somewhat and range from 1.9% to 127%.

The remaining four companies fall somewhere in between the above two extremes. Monitoring operating costs for these companies would have accounted for between 9.6% and 108% of average annual after-tax profits (losses). For the year in which profits were at their lowest monitoring operating costs would have made up between 1.2% and 289% of after-tax profits (losses). These percentages drop for the best year in the period from between 1.1% to 57%.

Capital expenditure data shown in Table 3.3 reveals that in the aggregate capital expenditures for the 17 companies have increased from a low of $445 million in 1983 to a high of $1.6 billion in 1985, averaging $1.4 billion over the period 1983-1987. This represents an increase of over 300% and reflects the recent improvement in the metal markets as companies begin to reinvest in expansion projects put on hold during the recession. This expenditure also reflects the major expansion in gold mining that has occurred in this decade.

Table 3.2

Impact of Monitoring Costs on Capital Expenditures and After-Tax Profits
For the Period 1983-1987
(Percentages)

	Capital Expenditures *			After Tax Profits*		
FIRM	Low	High	Average	Low	High	Average
Algoma Steel Corp.	0.1	0.4	0.1	-0.2	0.5	-0.4
American Barrick Resources Corp.	0.6	0.1	0.2	-1.2	1.1	-40.5
Canadian Salt Company**	3.1	1.9	2.5	2.1	1.8	1.9
Canamax Resources Inc.	53.8	0.9	1.7	-76.4	-5.0	-9.6
Denison Mines Ltd.	0.6	0.1	0.2	1.8	0.5	2.5
Dickenson	N/A	N/A	N/A	15.8	4.2	7.1
Domtar Inc. (Sifto)**	0.18	0.07	0.11	0.51	0.2	0.3
Falconbridge Ltd.	2.5	0.6	1.0	-26.7	1.1	1.8
Giant Yellowknife Mines Ltd.	24.3	0.6	2.3	41.0	6.3	13.9
Inco Ltd.	0.6	0.4	0.5	1333.3	1.9	-8.8
Lac Minerals Ltd.	0.3	0.1	0.2	-2.6	1.4	3.2
Minnova Inc.	1.0	0.2	0.4	-687.0	5.8	15.0
Muscocho Explorations Ltd.	9.3	6.7	N/A	-190.0	127.0	5025.0
Noranda Inc.	0.1	0.0	0.0	-0.1	0.1	1.4
Placer Dome Inc.	0.4	0.2	0.3	4.2	0.8	1.8
Rio Algom Ltd	0.8	0.1	0.3	2.2	1.2	1.5
St. Andrews Goldfields Ltd.	1.8	0.0	0.6	-289.0	57.0	108.0

* The highest monitoring costs were used in the calculation.
** Data was only available from 1983-1985.

Capital expenditures for the individual companies vary widely. Capital expenditures for seven of the 17 companies increased from 1983 to 1987. For the remaining companies no clear trend can be drawn.

Table 3.3

Annual Capital Expenditures
($ 000's)

FIRM	1983	1984	1985	1986	1987	Average
Algoma Steel Corp.	31,642	24,413	143,183	130,626	45,358	75,044
American Barrick Resources Corp.	N/A	19,140	17,411	27,796	134,585	49,733
Canadian Salt Company	10,194	7,051	6,149	N/A	N/A	7,798
Canamax Resources Inc.	24,930	565	11,253	15,808	35,111	17,533
Denison Mines Ltd.	N/A	111,798	196,016	193,918	49,472	137,801
Dickenson Mines Ltd.	N/A	N/A	N/A	N/A	N/A	N/A
Domtar Inc. (Salt)	107,700	132,900	284,400	N/A	N/A	175,000
Falconbridge Ltd.	24,321	52,683	43,476	106,658	85,702	62,568
Giant Yellowknife Mines Ltd.	N/A	2,888	2,244	2,829	88,122	24,021
Inco Ltd.	N/A	103,578	93,229	138,538	137,942	118,322
Lac Minerals Ltd.	46,334	91,296	176,799	43,588	105,398	92,683
Minnova Inc.	11,057	31,860	10,654	26,483	60,261	28,063
Muscocho Explorations Ltd.	N/A	2,178	7,637	4,955	(12,728)	511
Noranda Inc.	N/A	433,073	315,948	229,615	473,017	362,913
Placer Dome Inc.	N/A	195,379	133,938	130,900	157,900	154,529
Rio Algom Ltd	166,000	42,498	110,080	108,108	70,446	99,426
St. Andrews Goldfields Ltd.	23,169	4,927	3,118	6,360	5,996	8,714
Total	445,347	1,256,227	1,555,535	1,166,182	1,436,582	1,414,660

Source: Financial Post Information Service, 1988

The estimated monitoring capital costs as a percentage of annual capital expenditures are summarized in Table 3.2. The highest monitoring capital cost estimates were used in this analysis. Monitoring capital costs represent less than 2% of the average annual capital expenditures over the period for all but two companies. In fact, for 11 companies, capital costs for monitoring account for less than 1% of annual average capital expenditures during the period 1983-1987. Capital costs for monitoring would account for between .1% and 54% of total capital investments for these 17 companies when expenditures were at their lowest. When capital expenditures were at their highest, capital costs of monitoring would have represented from less than .1% to 6.7%.

The greatest impact of the monitoring capital costs would occur for Canamax in 1984 when capital monitoring costs would have represented 54% of the capital expenditure for that year. Capital expenditures for Canamax that year were extremely low; $565,000 down from $24,930,000 in 1983.

The impact on the 17 companies would be even less if tax incentives and breaks for capital expenditures were taken into account. The small impact which monitoring capital costs have on annual capital expenditures suggest that monitoring will not adversely alter the companies' capital investment plans.

Table 3.4 and 3.5 shows that the operating costs of monitoring would decrease the average return on capital employed and the return on assets ratio by less than 1% for 13 of the 17 firms evaluated.

For Giant Yellowknife, Canamax and Muscocho monitoring operating costs caused the return on capital employed ratio to decline by 2.21%, 1.34% and 2.42% respectively.

These small changes resulting from monitoring would therefore have little effect on the long term profitability of the 17 firms. Costs incurred because of the monitoring regulation would not likely cause these mines to close.

The foregoing analyses reveal the impacts of the monitoring cost estimates for 17 companies which account for 45 of the mines that are subject to the MISA regulation.

TABLE 3.4
PROJECTED DIFFERENCES IN THE RATES OF RETURN ON CAPITAL EMPLOYED
AS A RESULT OF THE ESTIMATED OPERATING COSTS OF MONITORING
(AS A PERCENT)

	1983	1984	1985	1986	1987	AVERAGE
ALGOMA STEEL CORP.	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
AMERICAN BARRICK RESOURCES	-0.32	-0.08	-0.08	-0.05	-0.02	-0.11
CANADIAN SALT COMPANY	-0.19	-0.21	-0.22	N/A	N/A	-0.13
CANAMAX RESOURCES INC.	-1.54	-1.46	-1.31	-1.31	-1.07	-1.34
DENISON MINES LTD.	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
DICKENSON MINES LTD.	N/A	N/A	N/A	N/A	N/A	N/A
DOMTAR INC. (SALT)	-0.01	-0.01	-0.01	N/A	N/A	-0.01
FALCONBRIDGE LTD.	-0.04	-0.04	-0.05	-0.02	-0.02	-0.03
GIANT YELLOWKNIFE MINES LTD	-1.58	-1.48	-1.26	-1.15	-0.30	-1.15
INCO LTD.	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
LAC MINERALS LTD.	-0.13	-0.08	-0.07	-0.06	-0.04	-0.08
MINNOVA INC.	-0.12	-0.11	-0.11	-0.10	-0.06	-0.10
MUSCOCHO EXPLORATIONS LTD.	-4.10	-3.79	-1.99	-1.56	-0.66	-2.42
NORANDA INC.	-0.01	-0.01	-0.01	-0.01	0.00	-0.01
PLACER DOME INC.	-0.06	-0.04	-0.05	-0.02	-0.02	-0.04
RIO ALGOM LTD.	-0.04	-0.04	-0.04	-0.03	-0.04	-0.04
ST. ANDREWS GOLDFIELDS LTD.	-0.80	-0.74	-0.68	-0.62	-0.56	-0.68

TABLE 3.5
PROJECTED DIFFERENCES IN THE RATES OF RETURN ON ASSETS
AS A RESULT OF THE ESTIMATED OPERATING COSTS OF MONITORING
(AS A PERCENT)

	1983	1984	1985	1986	1987	AVERAGE
ALGOMA STEEL	0.00	0.00	0.00	0.00	0.00	0.00
AMERICAN BARRICK RESOURCES	-0.27	-0.07	-0.07	-0.03	-0.02	-0.09
CANADIAN SALT COMPANY	-0.15	-0.14	-0.14	N/A	N/A	-0.09
CANAMAX RESOURCES	N/A	-0.86	-0.77	-0.75	-0.57	-0.59
DENISON MINES	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01
DICKENSON MINES LTD.	N/A	N/A	N/A	N/A	N/A	N/A
DOMTAR INC. (SALT)	-5.10	-7.80	-7.00	N/A	N/A	-3.98
FALCONBRIDGE	-0.04	-0.04	-0.03	-0.02	-0.02	-0.03
GIANT YELLOWKNIFE	-1.33	-1.26	-1.01	-0.97	-0.27	-0.97
INCO	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03
LAC MINERALS	-0.12	-0.07	-0.06	-0.06	-0.04	-0.07
MINNOVA	-0.11	-0.11	-0.10	-0.09	-0.06	-0.09
MUSCOCHO EXPLORATIONS	-3.42	-3.30	-1.80	-1.43	-0.60	-2.11
NORANDA	0.00	0.00	0.00	0.00	0.00	0.00
PLACER DOME	-0.08	-0.05	-0.06	-0.03	-0.03	-0.05
RIO ALGOM	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03
ST. ANDREW GOLDFIELDS	-0.40	-0.37	-0.34	-0.31	-0.28	-0.34

SOURCE: THE METAL MINING AND REFINING SECTOR IN ONTARIO,
A.R.A. CONSULTANTS, OCTOBER 1988

Most of the other 23 mines for which financial data are not available are gold mining operations. Moreover, the financial data used for the 17 companies is generally consolidated information. The profitability of a firm's Ontario mining operations cannot always be determined from the consolidated financial accounts. Firms may be engaged in activities unrelated to the mining sector, or they may be producers of several different metals at different mines. They may operate in other provinces or countries. (ARA, 1988, p. 58). Only two companies of the 17 listed in Table 3.2 obtained profits exclusively from mining - related sales (ARA, 1988). Therefore, for some mines who operate as profit oriented subsidiaries of parent companies, the preceding analyses may have underestimated the impacts of the costs of the monitoring regulations.

Finally, some mines are owned by joint ventures and holding companies so that it is very difficult to trace ownership of a particular mine location. Therefore, ultimate incidence of financial impacts cannot easily be determined and their significance is not readily apparent.

The monitoring regulations could have a positive impact on employment in Northern Ontario. The OMA estimated that each mine would require one additional employee full time to comply with the sampling requirements. If the mines fill this requirement externally, 52 jobs could be created for Northern Ontario for the 12-month period of the monitoring regulation. However, if some mines contract the services of a consultant in Southern Ontario for sampling then this figure would be somewhat lower.

The monitoring requirements will result in increased demand for laboratory services which could stimulate expansion of existing laboratory facilities in Thunder Bay, Ontario. Flow measurement and sampling equipment companies could also face increased demand.

Employment figures and production data for mines where data were available is presented in Table 1 in Appendix "D". These data give an indication of the relative size of the different mine properties.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Total average incremental capital and operating monitoring costs for the mineral industry Group "A" range from $13.1 to $18.0 million. Point estimates for individual mines are varied and range from $.24 to $.33 million.

Based on comparisons of the estimated monitoring costs of the proposed Regulation with potential costs of an "equitable" set of requirements, the proposed regulations which are plant and process specific appear to be cost-effective.

Costs of routine analyses for the current proposed process-specific regulations amount to as much as $2.3 million less than those analyses costs of the "equitable" scenario.

Throughout the early 1980's Canadian metal producers underwent significant restructuring, cost cutting and rationalization in response to lower metal prices caused by a decrease in demand and oversupply. The mines subject to MISA regulation face differing outlooks according to the metal produced.

The financial impacts of the estimated monitoring costs on the Group "A" sector were analyzed using historical publically available financial data for the period 1983-1987.

For all but two companies, monitoring capital costs represent less than 2% of average annual capital expenditures.

The impact of monitoring operating costs on after-tax profits varies substantially among individual companies. For nine firms, monitoring operating costs represent less than 4% of average after-tax profits. Monitoring operating costs represented over 100% of average annual after-tax profits for two firms, while for the remaining six companies the figures ranged from 7.1% to 40.5%.

Operating costs of monitoring would decrease the return on capital employed only slightly for the majority of the 17 firms evaluated. These small changes would therefore have little effect on the long term profitability of the firms.

The financial analyses indicated that for the 17 companies analyzed the monitoring costs appear to be fiscally manageable.

Three companies, Canamax, Muscocho, and St. Andrew Goldfields, had losses in 1987 and in previous years. However, these companies are in the process of bringing mines into production in the upcoming year. Future earnings from gold operations expected in 1989 suggest that these companies will have the sufficient funds to meet additional environmental expenditures due to monitoring.

It does not appear that the monitoring costs will affect the international competitiveness of this industry in Ontario to any significant degree.

The monitoring requirements may also produce benefits to the mining companies. Companies may gain goodwill, and will be seen by the public as having an environmental conscience. This is particularly valuable in today's society which is becoming increasingly concerned with environmental problems. Internationally, firms may be seen as good corporate players and will exert pressure for other companies to become environmentally aware. Companies may also make gains in productivity by improving processes as a result of the monitoring regulations. Also, there is a potential for plants to reduce raw material losses in wastewaters as a result of monitoring activities. Studies in the United States have shown that expenditures for environmental regulations have resulted in improvements in productivity and profits in the long term.

Compliance with the monitoring regulations will stimulate extra work at mines which is equivalent to 52 temporary positions jobs in Northern Ontario. Monitoring will also result in increased demand for laboratory services in the north and for flow measurement and sampling equipment. The monitoring database will be available to design cost-effective control programs aimed at eliminating toxic contamination where it occurs.

Lastly, the benefits of reducing pollution include enhanced recreation activities, better drinking water, better asethics and the knowledge that our society has taken a step towards preserving our water for generations to come.

4.2 Recommendations

In order to identify possible problems at an early stage, it is recommended that the MOE also monitor the actual incremental capital and operating costs of the monitoring activities during the tenure of the Regulations. Early identification of possible financial burdens will enable the MOE and the individual plant to review and assess workable solutions.

Also, at the end of the regulation period, each plant should report the actual incremental costs incurred in meeting MISA monitoring requirements in order to:

- validate and improve the cost-estimation procedures used in this report.

- monitor and assess the financial and employment impacts of the monitoring requirements.

- help to determine the full financial impact of the MISA requirements in both a domestic and international context when the costs of the limits regulations are determined.

Finally, when monitoring data and activities at these plants (and other industrial dischargers) are audited by the MOE personnel or their agents, information should be gathered to determine whether the monitoring activities have aided in making the operations or processes more efficient or productive.

APPENDIX "A"

APPENDIX 'A'

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION*
As of August 1989

PLANT	SAMPLING POINT (Effluent)
Iron	
Algoma Steel Corp. Ltd. - Algoma Ore Division	Process
Total - 1 mine	
Silver	
Aginco-Eagle Mines Ltd. - Leroy Project	Minewater EXP/DEV
Aginco-Eagle Mines Ltd. - Penna Mine	Minewater EXP/DEV
Total - 2 mines: 2 EXP/DEV	
Uranium	
Denison Mines Ltd. - Stanrock Property	Stormwater
Denison Mines Ltd. - Denison Property	Process-Stormwater
Cameco A Canadian Mining and Energy Corporation - Blind River Refinery	Smelter/Refinery
Cameo A Canadian Mining and Energy Corporation - Port Hope Refinery	3-Smelter/Refinery
Rio Algom Ltd. - Quirke Mine	Process
Rio Algom Ltd. - Panel Mine	Process
Rio Algom Ltd. - Pronto Property	Stormwater
Rio Algom Ltd. - Lacnor nordic	Stormwater
Rio Algom Ltd. - Stanleigh	Process
Total - 9 mines	

* Ownership as of June 15, 1989

APPENDIX 'A' (Continued)

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION

PLANT	SAMPLING POINT (Effluent)
Copper, Nickel, Lead, Zinc	
Falconbridge Ltd. - Onaping Mine	Minewater
Falconbridge Ltd. - Strathcona (Moose Lake)	Process
Falconbridge Ltd. - Falconbridge Property	Process
Falconbridge Ltd. - Lockerby Property	Minewater
Falconbridge Ltd. - Metallurgical Site	Process
Falconbridge Ltd. - Kidd Creek Mine	Minewater
Inco Limited - Garson	Minewater
Inco Limited - Nickel Refinery	Smelter/Refinery
Inco Limited - Shebandowan Property	Process
Inco Limited - Copper Cliff Treatment Plant	Process
Inco Limited - Crean Hill	Minewater
Inco Limited - Levack	Minewater
Inco Limited - Nolin Creek Treatment Plant	Stormwater
Inco Limited - Refinery	Smelter/Refinery
Inco Limited - Whistle	Minewater
Minnova Inc. - Winston Lake Mine	Process
Noranda Inc. - Geco Division	Process
Total - 17 mines	

APPENDIX 'A' (Continued)

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION

PLANT	SAMPLING POINT (Effluent)
Gold	
American Barrick Resources Corp. - McDermott Property	Process
Ateba Mines Ltd. - Magnet Mine	Process EXP/DEV
Ateba Mines Ltd. - Beardmore	Process EXP/DEV
Belmoral Mines Ltd. - Broulan Reef	Minewater EXP/DEV
Bond Gold Canada Inc. - Muskegsagagen Lake	Process
Canamax Resources Inc. - Marhill	Minewater
Canamax Resources Inc. - Bell Creek	Process
Canamax Resources Inc. - Kremzar Mine	Process
Chesbar Resources Inc. - Chester Township	Minewater EXP/DEV
Citadel Gold Mines Inc. - McMurry Township	Minewater
Dickenson Mines Ltd. - Arthur W. White Mine	Process
Eastmaque Gold Mines Ltd. - Kirkland Lake	Process
Falconbridge Ltd. Kidd Creek Division - Owl Creek Mine	Minewater EXP/DEV
Giant Yellowknife Mines Ltd. - ERG Resources	Process
Giant Yellowknife Mines Ltd. - Pamour #1	Process-Minewater
Giant Yellowknife Mines Ltd. - Pamour-Schumacher	Process-Minewater
Giant Yellowknife Mines Ltd. - Aunor-Delnite Property	Minewater
Giant Yellowknife Mines Ltd. - Ross Mine	Minewater EXP/DEV
Granges Minerals - Mishibishu Lake Area	Minewater EXP/DEV
Hemlo Gold Mines Inc. - Golden Giant Mine	Process
Lac D'Aminante Du Quebec Ltée - Aquarius Mine	Process EXP/DEV

APPENDIX 'A' (Continued)

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION

PLANT	SAMPLING POINT (Effluent)
Gold (Cont'd)	
Lac Minerals - Page Williams Mine	Process-Minewater
Lac Minerals - Macassa Division	Process
Muscocho Explorations Ltd. - Magnacon Mine	Process
Muscocho Explorations Ltd. - Majino Mine	Process-Minewater
Muscocho Explorations Ltd. - Jerome Mine	Minewater EXP/DEV
Orofino Resources Inc. - Scadding Mine	Process
Paymaster Gold Mines Ltd. - Paymaster	Minewater EXP/DEV
Placer-Dome Inc. - Dona Lake Mine	Process
Placer-Dome Inc. - Dome Mine	Process
Placer-Dome Inc. - Campbell Red Lake Mine	Process
Placer-Dome Inc. - Opapamiskan Lake	Minewater EXP/DEV
Placer-Dome Inc. - Detour Lake Mine	Process-Minewater
Renabie Gold Mines Ltd. - Renabie	Process-Minewater
St. Andrew Gold Fields - Stock Township	Minewater
Teck Corona Operating Corporation - David Bell Mine	Process
Total - 36 mines: 8 EXP/DEV	
Salt	
The Canadian Salt Company Ltd. - Windsor	2Process-Minewater
Domtar Inc. - Chemicals Group - SIFTO Salt Division	Process-Minewater
Total - 2 mines	

* Mine Ownerships as of June 15, 1989

APPENDIX B

APPENDIX B
TABLE 1

INCREMENTAL OPERATING AND CAPITAL COSTS BY MINE AND BY MONITORING ACTIVITY ($ 1988 cdn.)

Gold Subsector	FLOW MEASUREMENT CAPITAL LOW	FLOW MEASUREMENT CAPITAL HIGH	FLOW MEASUREMENT OPERATING LOW	FLOW MEASUREMENT OPERATING HIGH	TRANSPORT	MINE SAMPLING CAPITAL	MINE SAMPLING OPERATING	CONSULTANT SAMPLING CAPITAL	CONSULTANT SAMPLING OPERATING
American Barrick Resources	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Ateba Mines Inc.- Magnet EXP/DEV	0	0	0	0	0	0	0	0	0
Ateba Mines Inc.- Beardmore EXP/DEV	0	0	0	0	0	0	0	0	0
Belmoral Mines Broulan Reef- EXP/DEV	0	0	0	0	0	0	0	0	0
Bond Gold Canada Inc.- Muskegsagagen	20,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Canamax- Marhill	20,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Canamax- Bell Creek	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Canamax- Krezmar	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Chesbar Resources Inc. EXP/DEV	0	0	0	0	0	0	0	0	0
Citadel Gold Mines	20,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Dickenson Mines Ltd.- Arthur White Mine	5,000	15,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Eastmarque Gold Mines	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Falconbridge- Owl Creek EXP/DEV	0	0	0	0	0	0	0	0	0
Giant Yellowknife- ERG Resources	24,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Giant Yellowknife- Pamour 1	38,000	140,000	600	2,600	4,551	31,200	49,340	25,000	158,040
Giant Yellowknife - Pamour-Schumacher	23,500	140,000	600	2,600	4,551	31,200	49,340	25,000	158,040
Giant Yellowknife- Aunor Delnite	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Giant Yellowknife- Ross Mine EXP/DEV	0	0	0	0	0	0	0	0	0
Granges Exploration- EXP/DEV	0	0	0	0	0	0	0	0	0
Hemlo Gold Mines	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Lac D'Aminate Du Quebec- Aquarius EXP/DEV	0	0	0	0	0	0	0	0	0
Lac Minerals- Page Williams	19,000	70,000	600	2,600	4,551	31,200	49,340	25,000	158,040
Lac Minerals- Macassa	5,000	15,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Muscocho - Magnacon	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Muscocho- Majino	37,000	70,000	600	2,600	4,551	31,200	49,340	25,000	158,040
Muscocho- Jerome EXP/DEV	0	0	0	0	0	0	0	0	0
Orofina Resources-Scadding	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Paymaster Gold Mines Ltd.- Paymaster EXP/DEV	0	0	0	0	0	0	0	0	0
Placer - Dome -Dona lake	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Placer - Dome -Dome Mine	24,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Placer - Dome -Campbell Red Lake Mine	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Placer-Dome Detour Lake	48,000	140,000	600	2,600	4,551	31,200	49,340	25,000	158,040
Placer Dome Opapamiskan Exp/DEV	0	0	0	0	0	0	0	0	0
Renabie Gold Mines LTD	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
St. Andrew Goldfields	20,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Tech Corona Operating Corp.- David Bell Mine	19,000	70,000	300	1,300	4,551	31,200	47,820	25,000	158,040
Total	531,500	1,850,000	9,000	39,000	113,775	780,000	1,203,100	625,000	3,951,000

APPENDIX B
TABLE 1

INCREMENTAL OPERATING AND CAPITAL COSTS BY MINE AND BY MONITORING ACTIVITY ($1988 cdn.)

Gold Subsector	ROUTINE	CHARACTERIZATION	TOXICITY		REPORTING	
			Trout	Daphnia	OPERATING	CAPITAL
American Barrick Resources	53,143	15,250	1,440	960	37,700	10,000
Ateba Mines Inc.- Magnet EXP/DEV	0	0	0	0	0	0
Ateba Mines Inc.- Beardmore EXP/DEV	0	0	0	0	0	0
Belmoral Mines Broulan Reef- EXP/DEV	0	0	0	0	0	0
Bond Gold Canada Inc.- Muskegsagagen	53,143	15,250	1,440	960	37,700	10,000
Canamax- Marhill	52,567	15,442	1,440	960	37,700	10,000
Canamax- Bell Creek	53,143	15,250	1,440	960	24,000	10,000
Canamax- Krezmar	53,143	15,250	1,440	960	37,700	10,000
Chesbar Resources Inc. EXP/DEV	0	0	0	0	0	0
Citadel Gold Mines	53,143	15,250	1,440	960	37,700	10,000
Dickenson Mines Ltd.- Arthur White Mine	53,143	15,250	1,440	960	37,700	10,000
Eastmarque Gold Mines	53,143	15,250	1,440	960	37,700	10,000
Falconbridge- Owl Creek EXP/DEV	0	0	0	0	0	0
Giant Yellowknife- ERG Resources	53,143	15,250	1,440	960	37,700	10,000
Giant Yellowknife- Pamour 1	105,710	30,692	2,880	1,920	37,700	10,000
Giant Yellowknife - Pamour-Schumacher	105,710	30,692	1,440	960	37,700	10,000
Giant Yellowknife- Aunor Delnite	52,567	15,442	1,440	960	24,000	10,000
Giant Yellowknife- Ross Mine EXP/DEV	0	0	0	0	0	0
Granges Exploration- EXP/DEV	0	0	0	0	0	0
Hemlo Gold Mines	53,143	15,250	1,440	960	37,700	10,000
Lac D'Aminate Du Quebec- Aquarius EXP/DEV	0	0	0	0	0	0
Lac Minerals- Page Williams	53,143	15,250	2,880	1,920	37,700	10,000
Lac Minerals- Macassa	53,143	15,250	1,440	960	37,700	10,000
Muscocho - Magnacon	53,143	15,250	1,440	960	37,700	10,000
Muscocho- Majino	105,710	30,692	2,880	1,920	24,000	10,000
Muscocho- Jerome EXP/DEV	0	0	0	0	0	0
Orofina Resources-Scadding	52,567	15,442	1,440	960	24,000	10,000
Paymaster Gold Mines Ltd.- Paymaster EXP/DEV		0	0	0	0	0
Placer - Dome -Dona lake	53,143	15,250	1,440	960	37,700	10,000
Placer - Dome -Dome Mine	105,710	30,692	1,440	960	37,700	10,000
Placer - Dome -Campbell Red Lake Mine	53,143	15,250	1,440	960	37,700	10,000
Placer-Dome Detour Lake	105,710	30,692	2,880	1,920	37,700	10,000
Placer Dome Opapamiskan Exp/DEV	0	0	0	0	0	0
Renabie Gold Mines LTD	105,710	30,692	2,880	1,920	37,700	10,000
St. Andrew Goldfields	52,567	15,442	1,440	960	37,700	10,000
Tech Corona Operating Corp.- David Bell Mine	53,143	15,250	1,440	960	37,700	10,000
Total	1,641,673	474,670	43,200	28,800	887,700	250,000

APPENDIX B
TABLE 1 (CONT.)

INCREMENTAL OPERATING AND CAPITAL COSTS BY MINE AND BY MONITORING ACTIVITY ($ 1988 cdn.)

Iron Subsector	FLOW MEASUREMENT CAPITAL LOW	CAPITAL HIGH	OPERATING LOW	OPERATING HIGH	TRANSPORT	MINE SAMPLING CAPITAL	MINE SAMPLING OPERATING	CONSULTANT SAMPLING CAPITAL	CONSULTANT SAMPLING OPERATING
Algoma	20,000	70,000	300	1,300	4,334	31,200	47,820	25,000	149,707
Total	20,000	70,000	300	1,300	4,334	31,200	47,820	25,000	149,707

Uranium Subsector	FLOW MEASUREMENT CAPITAL LOW	CAPITAL HIGH	OPERATING LOW	OPERATING HIGH	TRANSPORT	MINE SAMPLING CAPITAL	MINE SAMPLING OPERATING	CONSULTANT SAMPLING CAPITAL	CONSULTANT SAMPLING OPERATING
Denison- Stanrock	19,000	70,000	300	1,300	3,392	31,200	47,820	25,000	149,240
Denison - Elliot Lake	46,000	140,000	600	2,600	3,392	31,200	49,340	25,000	149,240
Cameco - Blind River Refinery	19,000	70,000	300	1,300	3,392	31,200	47,820	25,000	149,240
Cameco - Port Hope	56,000	210,000	900	3,900	3,392	31,200	50,860	25,000	149,240
Rio Algom -Quirke Mine	5,000	15,000	300	1,300	3,392	31,200	47,820	25,000	149,240
Rio Algom - Panel	5,000	15,000	300	1,300	3,392	31,200	47,820	25,000	149,240
Rio Algom -Pronto	19,000	70,000	300	1,300	3,392	31,200	47,820	25,000	149,240
Rio Algom -Lacnor	19,000	70,000	300	1,300	3,392	31,200	47,820	25,000	149,240
Rio Algom -Stanleigh	5,000	15,000	300	1,300	3,392	31,200	47,820	25,000	149,240
TOTAL	193,000	675,000	3,600	15,600	30,528	280,800	434,940	225,000	1,343,160

Copper, Lead, Nickel, Zinc Subsector	FLOW MEASUREMENT CAPITAL LOW	CAPITAL HIGH	OPERATING LOW	OPERATING HIGH	TRANSPORT	MINE SAMPLING CAPITAL	MINE SAMPLING OPERATING	CONSULTANT SAMPLING CAPITAL	CONSULTANT SAMPLING OPERATING
Falconbridge - Onaping	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Falconbridge - Strathcona	20,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Falconbridge - Falconbridge	19,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Falconbridge - Lockerby	19,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Falconbridge - Metalurgical Site	20,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Falconbridge - Kidd Creek Mine	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Carson	20,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Nickel	20,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Shebandowan	19,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Copper Cliff	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Crean	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Levack	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Nolin	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Refinery	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Inco-Whistle	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Minnova	19,000	70,000	300	1,300	4,333	31,200	47,820	25,000	158,040
Noranda - Geco	5,000	15,000	300	1,300	4,333	31,200	47,820	25,000	158,040
TOTAL	201,000	695,000	5,100	22,100	73,661	530,400	812,940	425,000	2,686,680

APPENDIX B
TABLE 1 (CONT.)

INCREMENTAL OPERATING AND CAPITAL COSTS BY MINE AND BY MONITORING ACTIVITY ($ 1988 cdn.)

Iron Subsector	ROUTINE	CHARACTERIZATION	TOXICITY		REPORTING	
			Trout	Daphnia	OPERATING	CAPITAL
Algoma	28,013	15,680	1,440	960	37,700	10,000
Total	28,013	15,680	1,440	960	37,700	10,000

Uranium Subsector	ROUTINE	CHARACTERIZATION	TOXICITY		REPORTING	
			Trout	Daphnia	OPERATING	CAPITAL
Denison- Stanrock	16,007	6,597	1,440	960	37,700	10,000
Denison - Elliot Lake	35,186	31,629	2,880	1,920	37,700	10,000
Cameco - Blind River Refinery	28,280	15,832	1,440	960	24,000	10,000
Cameco - Port Hope	84,840	47,496	4,320	2,880	24,000	10,000
Rio Algom -Quirke Mine	28,589	15,585	1,440	960	37,700	10,000
Rio Algom - Panel	28,589	15,585	1,440	960	37,700	10,000
Rio Algom -Pronto	16,007	6,597	1,440	960	37,700	10,000
Rio Algom -Lacnor	16,007	6,597	1,440	960	37,700	10,000
Rio Algom -Stanleigh	28,589	15,585	1,440	960	37,700	10,000
TOTAL	282,094	161,503	17,280	11,520	311,900	90,000

Copper, Lead, Nickel, Zinc Subsector	ROUTINE	CHARACTERIZATION	TOXICITY		REPORTING	
			Trout	Daphnia	OPERATING	CAPITAL
Falconbridge - Onaping	48,757	15,344	1,440	960	37,700	10,000
Falconbridge - Strathcona	49,115	15,344	1,440	960	37,700	10,000
Falconbridge - Falconbridge	49,115	15,344	1,440	960	37,700	10,000
Falconbridge - Lockerby	48,757	15,344	1,440	960	37,700	10,000
Falconbridge - Metalurgical Site	49,115	15,344	1,440	960	37,700	10,000
Falconbridge - Kidd Creek Mine	48,757	15,344	1,440	960	37,700	10,000
Inco-Carson	48,757	15,344	1,440	960	37,700	10,000
Inco-Nickel	44,492	15,488	1,440	960	37,700	10,000
Inco-Shebandowan	49,115	15,344	1,440	960	37,700	10,000
Inco-Copper Cliff	49,115	15,344	1,440	960	37,700	10,000
Inco-Crean	48,757	15,344	1,440	960	37,700	10,000
Inco-Levack	48,757	15,344	1,440	960	37,700	10,000
Inco-Nolin	9,043	11,629	1,440	960	37,700	10,000
Inco-Refinery	44,492	15,488	1,440	960	37,700	10,000
Inco-Whistle	48,757	15,344	1,440	960	37,700	10,000
Minnova	49,115	15,344	1,440	960	37,700	10,000
Noranda - Geco	49,115	15,344	1,440	960	37,700	10,000
TOTAL	783,131	257,421	24,480	16,320	640,900	170,000

Appendix "B"
TABLE 2
TOTAL OPERATING AND CAPITAL COSTS OF MONITORING
BY MINE AND SAMPLING SCENARIO ($ 1988 cdn.)

SCENARIO - IN HOUSE SAMPLING

Gold Subsector	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
American Barrick Resources	161,164	162,164	60,200	111,200	221,364	273,364
Ateba Mines- Magnet EXP/DEV	0	0	0	0	0	0
Ateba Mines- Beardmore EXP/DEV	0	0	0	0	0	0
Belmoral Mines- Broulan Reef EXP/DEV	0	0	0	0	0	0
Bond Gold Canada Inc.- Muskeszagagen	161,164	162,164	61,200	111,200	222,364	273,364
Canamax- Marhill	160,780	161,780	61,200	111,200	221,980	272,980
Canamax- Bell Creek	147,464	148,464	60,200	111,200	207,664	259,664
Canamax- Krezmar	161,164	162,164	60,200	111,200	221,364	273,364
Chesbar Resources Inc. EXP/DEV	0	0	0	0	0	0
Citadel Gold Mines Inc.	161,164	162,164	61,200	111,200	222,364	273,364
Dickenson Mines Ltd.- Arthur White Mine	161,164	162,164	46,200	56,200	207,364	218,364
Eastmarque Gold Mines	163,564	164,564	60,200	111,200	223,764	275,764
Falconbridge- Owl Creek Mine EXP/DEV	0	0	0	0	0	0
Giant Yellowknife- ERG Resources	161,164	162,164	65,200	111,200	226,364	273,364
Giant Yellowknife- Pamour 1	230,993	232,993	80,200	181,200	311,193	414,193
Giant Yellowknife - Pamour-Schumacher	230,993	232,993	64,700	181,200	295,693	414,193
Giant Yellowknife- Aunor Delnite	147,080	148,080	60,200	111,200	207,280	259,280
Giant Yellowknife- Ross Mine EXP/DEV	0	0	0	0	0	0
Granges Exploration Ltd.- Mishibishu EXP/DEV	0	0	0	0	0	0
Hemlo Gold- Golden Giant Mine	161,164	162,164	60,200	111,200	221,364	273,364
Lac D'Amiante- Aquarius Mine EXP/DEV	0	0	0	0	0	0
Lac Minerals- Page Williams	162,984	164,984	79,200	111,200	242,184	276,184
Lac Minerals- Macassa	161,164	162,164	46,200	56,200	207,364	218,364
Muscocho - Magnacon	163,564	164,564	60,200	111,200	223,764	275,764
Muscocho- Majino	217,293	219,293	78,200	111,200	295,493	330,493
Muscocho- Jerome EXP/DEV	0	0	0	0	0	0
Orofina -Scadding	147,080	148,080	60,200	111,200	207,280	259,280
Paymaster Gold Mines Ltd.- Paymaster EXP/DEV	0	0	0	0	0	0
Placer - Dome -Dona lake	163,564	164,564	60,200	111,200	223,764	275,764
Placer - Dome -Dome Mine	229,173	230,173	65,200	111,200	294,373	341,373
Placer - Dome -Campbell Red Lake Mine	163,564	164,564	60,200	111,200	223,764	275,764
Placer-Dome- Detour Lake	230,993	232,993	89,200	181,200	320,193	414,193
Placer Dome- Opapamiskan EXP/DEV	0	0	0	0	0	0
Renabie Gold Mines LTD	229,173	230,173	60,200	111,200	289,373	341,373
St. Andrew Goldfields- Stock	160,780	161,780	61,200	111,200	221,980	272,980
Tech Corona Operating Corporation	161,164	162,164	60,200	111,200	221,364	273,364
TOTAL	4,399,518	4,429,518	1,581,500	2,880,000	5,981,018	7,309,518

Appendix "B"
TABLE 2
TOTAL OPERATING AND CAPITAL COSTS OF MONITORING
BY MINE AND SAMPLING SCENARIO ($ 1988 cdn.)

SCENARIO - CONSULTANT SAMPLING

Gold Subsector	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
American Barrick Resources	271,384	272,384	54,000	105,000	325,384	377,384
Ateba Mines- Magnet EXP/DEV	0	0	0	0	0	0
Ateba Mines- Beardmore EXP/DEV	0	0	0	0	0	0
Belmoral Mines- Broulan Reef EXP/DEV	0	0	0	0	0	0
Bond Gold Canada Inc.- Muskesagagen	271,384	272,384	55,000	105,000	326,384	377,384
Canamax- Marhill	271,000	272,000	55,000	105,000	326,000	377,000
Canamax- Bell Creek	257,684	258,684	54,000	105,000	311,684	363,684
Canamax- Krezmar	271,384	272,384	54,000	105,000	325,384	377,384
Chesbar Resources Inc. EXP/DEV	0	0	0	0	0	0
Citadel Gold Mines Inc.	271,384	272,384	55,000	105,000	326,384	377,384
Dickenson Mines Ltd.- Arthur White Mine	271,384	272,384	40,000	50,000	311,384	322,384
Eastmarque Gold Mines	273,784	274,784	54,000	105,000	327,784	379,784
Falconbridge- Owl Creek Mine EXP/DEV	0	0	0	0	0	0
Giant Yellowknife- ERG Resources	271,384	272,384	59,000	105,000	330,384	377,384
Giant Yellowknife- Pamour 1	339,693	341,693	74,000	175,000	413,693	516,693
Giant Yellowknife - Pamour-Schumacher	339,693	341,693	58,500	175,000	398,193	516,693
Giant Yellowknife- Aunor Delnite	257,300	258,300	54,000	105,000	311,300	363,300
Giant Yellowknife- Ross Mine EXP/DEV	0	0	0	0	0	0
Granges Exploration Ltd.- Mishibishu EXP/DEV	0	0	0	0	0	0
Hemlo Gold- Golden Giant Mine	271,384	272,384	54,000	105,000	325,384	377,384
Lac D'Amiante- Aquarius Mine EXP/DEV	0	0	0	0	0	0
Lac Minerals- Page Williams	271,684	273,684	73,000	105,000	344,684	378,684
Lac Minerals- Macassa	271,384	272,384	40,000	50,000	311,384	322,384
Muscocho - Magnacon	273,784	274,784	54,000	105,000	327,784	379,784
Muscocho- Majino	325,993	327,993	72,000	105,000	397,993	432,993
Muscocho- Jerome EXP/DEV	0	0	0	0	0	0
Orofina -Scadding	257,300	258,300	54,000	105,000	311,300	363,300
Paymaster Gold Mines Ltd.- Paymaster EXP/DEV	0	0	0	0	0	0
Placer - Dome -Dona lake	273,784	274,784	54,000	105,000	327,784	379,784
Placer - Dome -Dome Mine	339,393	340,393	59,000	105,000	398,393	445,393
Placer - Dome -Campbell Red Lake Mine	273,784	274,784	54,000	105,000	327,784	379,784
Placer-Dome- Detour Lake	339,693	341,693	83,000	175,000	422,693	516,693
Placer Dome- Opapamiskan Exp/DEV	0	0	0	0	0	0
Renabie Gold Mines LTD	339,393	340,393	54,000	105,000	393,393	445,393
St. Andrew Goldfields- Stock	271,000	272,000	55,000	105,000	326,000	377,000
Tech Corona Operating Corporation	271,384	272,384	54,000	105,000	325,384	377,384
TOTAL	7,147,418	7,177,418	1,426,500	2,725,000	8,573,918	9,902,418

Appendix "B"
TABLE 2 (cont.)
TOTAL OPERATING AND CAPITAL COSTS OF MONITORING
BY MINE AND SAMPLING SCENARIO ($ 1988 cdn.)

SCENARIO - IN HOUSE SAMPLING

Subsector Iron	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Algoma Steel Corp. Ltd - Algoma Ore Division	136,247	137,247	61,200	111,200	197,447	248,447
Total	136,247	137,247	61,200	111,200	197,447	248,447

Subsector Uranium	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Denison Mines Ltd.- Stanrock Property	114,216	115,216	60,200	111,200	174,416	226,416
Denison Mines Ltd.- Elliot Lake	162,647	164,647	87,200	181,200	249,847	345,847
Cameco - Blind River Refinery	122,024	123,024	60,200	111,200	182,224	234,224
Cameco - Port Hope Refinery	218,688	221,688	97,200	251,200	315,888	472,888
Rio Algom Ltd.- Quirke Mine	135,786	136,786	46,200	56,200	181,986	192,986
Rio Algom Ltd.- Panel Mine	135,786	136,786	46,200	56,200	181,986	192,986
Rio Algom Ltd.- Pronto Property	114,216	115,216	60,200	111,200	174,416	226,416
Rio Algom Ltd. - Lacnor Nordic	114,216	115,216	60,200	111,200	174,416	226,416
Rio Algom Ltd. - Stanleigh Mine	135,786	136,786	46,200	56,200	181,986	192,986
TOTAL	1,253,365	1,265,365	563,800	1,045,800	1,817,165	2,311,165

Subsector Copper, Nickel, Lead, Zinc	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Falconbridge Ltd- Onaping Mine	156,654	157,654	46,200	56,200	202,854	213,854
Falconbridge Ltd- Strathcona	157,012	158,012	61,200	111,200	218,212	269,212
Falconbridge Ltd.- Falconbridge Property	157,012	158,012	60,200	111,200	217,212	269,212
Falconbridge Ltd.- Lockerby Property	156,654	157,654	60,200	111,200	216,854	268,854
Falconbridge Ltd. - Metalurgical Site	157,012	158,012	61,200	111,200	218,212	269,212
Falconbridge Ltd.- Kidd Creek Mine	156,654	157,654	46,200	56,200	202,854	213,854
Inco Ltd - Carson	156,654	157,654	61,200	111,200	217,854	268,854
Inco Ltd. - Nickel Refinery	152,533	153,533	61,200	111,200	213,733	264,733
Inco Ltd. - Shebandowan Property	157,012	158,012	60,200	111,200	217,212	269,212
Inco Ltd - Copper Cliff Treatment Plant	157,012	158,012	46,200	56,200	203,212	214,212
Inco Ltd. - Crean Hill	156,654	157,654	46,200	56,200	202,854	213,854
Inco Ltd. - Levack	156,654	157,654	46,200	56,200	202,854	213,854
Inco Ltd. - Nolin Creek Treatment Plant	113,225	114,225	46,200	56,200	159,425	170,425
Inco Ltd. - Refinery	152,533	153,533	46,200	56,200	198,733	209,733
Inco Ltd. - Whistle	156,654	157,654	46,200	56,200	202,854	213,854
Minnova Inc. - Winston Lake Mine	157,012	158,012	60,200	111,200	217,212	269,212
Noranda Inc.- Geco Division	157,012	158,012	46,200	56,200	203,212	214,212
TOTAL	2,613,953	2,630,953	901,400	1,395,400	3,515,353	4,026,353

Appendix "B"
TABLE 2 (cont.)
TOTAL OPERATING AND CAPITAL COSTS OF MONITORING
BY MINE AND SAMPLING SCENARIO ($ 1988 cdn.)

SCENARIO - CONSULTANT SAMPLING

Subsector Iron	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Algoma Steel Corp. Ltd - Algoma Ore Division	238,134	239,134	55,000	105,000	293,134	344,134
Total	238,134	239,134	55,000	105,000	293,134	344,134

Subsector Uranium	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Denison Mines Ltd.- Stanrock Property	215,636	216,636	54,000	105,000	269,636	321,636
Denison Mines Ltd.- Elliot Lake	262,547	264,547	81,000	175,000	343,547	439,547
Cameco - Blind River Refinery	223,444	224,444	54,000	105,000	277,444	329,444
Cameco - Port Hope Refinery	317,068	320,068	91,000	245,000	408,068	565,068
Rio Algom Ltd.- Quirke Mine	237,206	238,206	40,000	50,000	277,206	288,206
Rio Algom Ltd.- Panel Mine	237,206	238,206	40,000	50,000	277,206	288,206
Rio Algom Ltd.- Pronto Property	215,636	216,636	54,000	105,000	269,636	321,636
Rio Algom Ltd. - Lacnor Nordic	215,636	216,636	54,000	105,000	269,636	321,636
Rio Algom Ltd. - Stanleigh Mine	237,206	238,206	40,000	50,000	277,206	288,206
TOTAL	2,161,585	2,173,585	508,000	990,000	2,669,585	3,163,585

Subsector Copper, Nickel, Lead, Zinc	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Falconbridge Ltd- Onaping Mine	266,874	267,874	40,000	50,000	306,874	317,874
Falconbridge Ltd- Strathcona	267,232	268,232	55,000	105,000	322,232	373,232
Falconbridge Ltd.- Falconbridge Property	267,232	268,232	54,000	105,000	321,232	373,232
Falconbridge Ltd.- Lockerby Property	266,874	267,874	54,000	105,000	320,874	372,874
Falconbridge Ltd. - Metalurgical Site	267,232	268,232	55,000	105,000	322,232	373,232
Falconbridge Ltd.- Kidd Creek Mine	266,874	267,874	40,000	50,000	306,874	317,874
Inco Ltd - Carson	266,874	267,874	55,000	105,000	321,874	372,874
Inco Ltd. - Nickel Refinery	262,753	263,753	55,000	105,000	317,753	368,753
Inco Ltd. - Shebandowan Property	267,232	268,232	54,000	105,000	321,232	373,232
Inco Ltd - Copper Cliff Treatment Plant	267,232	268,232	40,000	50,000	307,232	318,232
Inco Ltd. - Crean Hill	266,874	267,874	40,000	50,000	306,874	317,874
Inco Ltd. - Levack	266,874	267,874	40,000	50,000	306,874	317,874
Inco Ltd. - Nolin Creek Treatment Plant	223,445	224,445	40,000	50,000	263,445	274,445
Inco Ltd. - Refinery	262,753	263,753	40,000	50,000	302,753	313,753
Inco Ltd. - Whistle	266,874	267,874	40,000	50,000	306,874	317,874
Minnova Inc. - Winston Lake Mine	267,232	268,232	54,000	105,000	321,232	373,232
Noranda Inc.- Geco Division	267,232	268,232	40,000	50,000	307,232	318,232
TOTAL	4,487,693	4,504,693	796,000	1,290,000	5,283,693	5,794,693

APPENDIX "C"

APPENDIX "C"

Table 1
Incremental Monitoring Costs as a Percentage of Annual After- Tax Profit
Inhouse Mine Sampling (High Operational)

FIRM	1983	1984	1985	1986	1987	Average
Algoma Steel Corp.	-0.08%	-0.23%	-3.60%	-0.08%	0.27%	-0.20%
American Barrick Resources Corp.	-3.66%	-1.01%	-0.72%	1.08%	0.66%	-24.10%
Canadian Salt Company	1.91%	2.14%	1.83%	N/A	N/A	1.95%
Canamax Resources Inc.	-44.91%	-8.66%	-9.17%	-3.40%	-2.93%	-5.66%
Denison Mines Ltd.	0.28%	0.35%	-0.18%	0.63%	1.03%	1.46%
Dickenson	4.49%	5.90%	9.42%	3.53%	2.52%	4.24%
Domtar Inc. (Salt)	0.51%	0.22%	0.18%	N/A	N/A	0.25%
Falconbridge Ltd.	-26.74%	1.18%	2.46%	1.35%	1.30%	1.83%
Giant Yellowknife Mines Ltd.	18.44%	41.04%	13.64%	20.18%	6.33%	13.91%
Inco Ltd.	-0.58%	-1.77%	2.62%	772.88%	1.09%	-5.08%
Lac Minerals Ltd.	1.17%	1.12%	3.08%	-1.54%	0.85%	1.92%
Minnova Inc.	-405.13%	17.73%	85.41%	3.40%	4.85%	8.83%
Muscocho Explorations Ltd.	264.83%	-421.98%	80.84%	-252.63%	-121.14%	3200.00%
Noranda Inc.	-0.46%	-3.55%	-0.06%	0.36%	0.05%	0.84%
Placer Dome Inc.	3.21%	3.20%	2.66%	1.00%	0.59%	1.36%
Rio Algom Ltd	1.25%	0.87%	0.73%	0.91%	0.69%	0.85%
St. Andrews Goldfields Ltd.	37.16%	33.96%	63.78%	88.52%	-172.34%	64.49%
Total	-5.36%	2.98%	-8.44%	4.11%	0.80%	2.83%

TABLE 2
Incremental Monitoring Costs as a Percentage of Annual Capital Expenditures

FIRM	1983	1984	1985	1986	1987	Average
Algoma Steel Corp.	0.32%	0.41%	0.07%	0.08%	0.22%	0.13%
American Barrick Resources Corp.	N/A	0.53%	0.58%	0.36%	0.08%	0.20%
Canadian Salt Company	1.88%	2.72%	3.12%	N/A	N/A	2.46%
Canamax Resources Inc.	1.22%	53.81%	2.70%	1.92%	0.87%	1.73%
Denison Mines Ltd.	N/A	0.24%	0.14%	0.14%	0.55%	0.20%
Dickenson Mines Ltd.	N/A	N/A	N/A	N/A	N/A	N/A
Domtar Inc. (Salt)	0.18%	0.15%	0.07%	N/A	N/A	0.11%
Falconbridge Ltd.	2.46%	1.14%	1.38%	0.56%	0.70%	0.96%
Giant Yellowknife Mines Ltd.	N/A	18.87%	24.29%	19.26%	0.62%	2.27%
Inco Ltd.	N/A	0.56%	0.62%	0.42%	0.42%	0.49%
Lac Minerals Ltd.	0.22%	0.16%	0.08%	0.34%	0.14%	0.16%
Minnova Inc.	1.83%	0.32%	0.95%	0.38%	0.17%	0.36%
Muscocho Explorations Ltd.	N/A	9.27%	2.65%	4.08%	-1.59%	39.57%
Noranda Inc.	N/A	0.03%	0.05%	0.06%	0.03%	0.04%
Placer Dome Inc.	N/A	0.24%	0.35%	0.36%	0.30%	0.31%
Rio Algom Ltd	0.06%	0.80%	0.31%	0.32%	0.48%	0.34%
St. Andrews Goldfields Ltd.	N/A	2.05%	3.24%	1.59%	1.68%	1.16%
Total	1.01%	0.36%	0.29%	0.39%	0.31%	0.32%

Note: The highest capital expenditures were used in the analyses

APPENDIX "D"

APPENDIX "D"

Table 1
EMPLOYMENT AND CAPACITY OF INDIVIDUAL MINES IN ONTARIO

MINES Gold Subsector	NO. OF EMPLOYEES (1987)	CAPACITY TONS\DAY (1987) **
American Barrick Resources	155	1,500
Associated Porcupine Mines	-	-
Ateba-Roxmark EXP/DEV	28	200
Belmoral Mines LTD	330	2,000
Bond Gold Canada Ltd.	-	-
Canamax Bell Creek *	93	385
Canamax Krezmar *	53	500
Chesbar Resources Ltd.	-	-
Citadel Gold Mines LTD *	91	500
Dickenson Mines Ltd. *	381	700
Diepdaume	-	600
Giant Yellowknife- Pamour 1	347	2,800
Giant Yellowknife- Schumacher	305	2,700
Giant Yellowknife- Timmins	15	400
Giant Yellowknife- Ross Mine	81	750
Granges Exploration	68	500
Hemlo Gold *	279	3,000
Owl Creek (Div. of Kidd Creek)	15	500
Lac D'Aminate	-	-
Lac - Page Williams *	518	3,000
Lac - Macassa *	310	500
Muscocho - Magnacon Project	-	600
Muscocho- Majino	-	400
Muscocho- Jerome	-	-
Orofina -Scadding	18	200
Placer - Dome -Dona lake	2,600	550
Placer - Dome -Dome Mine *	757	3,000
Placer - Dome -Campbell	2,075	1,200
Placer - Dome -Opapamiskan	-	-
Placer - Dome -Detour Lake	306	2200
Renabie *	182	700
St. Andrew Goldfields- Stock	-	500
Tech Corona *	200	1,000
Total:	9,207	30,885

APPENDIX "D"

Table 1
EMPLOYMENT AND CAPACITY OF INDIVIDUAL MINES IN ONTARIO

MINES Iron Subsector	NO. OF EMPLOYEES (1987)	CAPACITY TONS\DAY (1987) **
Algoma *	334	3,750
Total:	334	3,750
Silver Subsector		
Aginco-Eagle -Lery EXP/DEV	125	300
Aginco-Eagle - Decline EXP/DEV	-	-
TOTAL:	125	300
Uranium Subsector		
Denison- Stanrock }	-	-
Denison - Elliot Lake }*	1,953	15,000
Cameco - Blind River Refinery	-	-
Cameco - Port Hope	-	-
Rio Algom -Quirke Mine *	1,169	7,000
Rio Algom - Panel *	664	3,300
Rio Algom -Pronto	-	-
Rio Algom -Lacnor	-	-
Rio Algom -Stanleigh *	535	5,000
TOTAL:	4,321	30,300

APPENDIX "D"

Table 1
EMPLOYMENT AND CAPACITY OF INDIVIDUAL MINES IN ONTARIO

Copper, Nickel, Lead Subsector	NO. OF EMPLOYEES (1987)	CAPACITY TONS\DAY (1987) **
Falconbridge - Onaping	-	-
Falconbridge - Strathcona	-	10,000
Falconbridge - Falconbridge	2,315	2,700
Falconbridge - Lockerby	-	8,100
Inco-Carson	}	4,000
Inco-Nickel	}	18,000
Inco-Shebandowan	}	3,900
Inco-Copper Cliff	}	5,400
Inco-Crean	} 8,348	3,000
Inco-Levack	}	7,000
Inco-Nolin	}	-
Inco-Refinery	}	-
Inco-Whistle	}	-
Kidd Creek - Metalurgical Site *	1,383	-
Kidd Creek - Kidd Creek *	990	12,000
Minnova- Winston Lake *	121	1,000
Noranda - Geco *	491	5,000
TOTAL:	13,648	80,100
SECTOR TOTAL: #	27,409	161,490

Does not reflect actual total for Ontario since data is not available for some of the mines.

Source: Canadian Mines Handbook, 1988-89
* Mines Accident Prevention Association Ontario Injury Statistics, Jan - Nov 1988
** Canadian Mines Handbook, 1988-89, and from figures obtained from the Ontario Mining Association

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